Asbestos Exposure Report of Steve M. Hays,

Graham Yates, et al, v. Air Liquid Systems Corporation, et al.

In the United Stated District Circuit

For the Eastern District of North Carolina

July 16, 2013

Plaintiffs' Exhibit M1

1. Introduction

This report is based on a review of the two depositions of Graham Yates, February 13, 2013, pertinent literature and exposure assessment studies cited in this report and my qualifications and experience as a Certified Industrial Hygienist. Selected industrial hygiene, scientific, and regulatory publications upon which I relied are cited in Appendix A. My curricula vita is in Appendix B. My expert testimony history is given in Appendix C. My compensation is given in Appendix D. I also relied on my general knowledge in the topic areas, including my library of relevant publications. My opinions may be supplemented or changed if new evidence/information is presented to me.

The purpose of this report is to provide industrial hygiene opinions about 1) exposure and potential exposure to airborne asbestos, 2) as well as specific exposures from various asbestos-containing products (Sections 15-17).

“Asbestos has been used in cement products, plaster, fireproof textiles, vinyl floor tiles, thermal and acoustical insulation, and sprayed materials.” (EPA, 1979) “Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water or evaporate and are resistant to heat, fire, chemical and biological degradation… As a result of its low cost and desirable properties such as heat and fire resistance, wear and friction characteristics, tensile strength, heat, electrical and sound insulation, adsorption capacity, and resistance to chemical and biological attack, asbestos has been used in a very large number of applications and types of products.” (ATSDR, 2001)

2. Industrial Hygiene

Historic exposures were mostly measured using an impinger, which gave results in million particles per cubic foot of air (mppcf), or using phase contrast microscopy (PCM) to examine sampling filters, which is an optical microscopy technique that gave results in fibers per cubic centimeter of air (f/cm^3). It should be noted that units "f/cc" or "f/cm^3" (fibers per cubic centimeters) and "f/ml" (fibers per milliliter), have the same quantitative meaning. The PCM method measures only fibers equal to or longer than 5 micrometers, with an aspect ratio (length to width) of equal to or greater than 3 to 1. Short fibers are not counted, and thin fibers are not even seen by the analyst because the optical scope cannot resolve fiber widths less than 0.25 micrometers. The mppcf measurement gives no information about fiber size, large or small, since it only provides a total numerical count of dust particles present. With these historic data, and with contemporary PCM data, the total number of fibers present and the fiber size distribution are not known. Transmission electron microscopy (TEM) is another and more current method of analysis. This approach is appealing because it quantitatively measures only airborne asbestos fibers and reports them in structures per cubic centimeter (s/cc). This method can also distinguish between the different types of asbestos. Using historic data on average exposures or ranges of exposures in a given operation or job to estimate exposures for an individual or a cohort must be done with these limitations and/or capabilities in mind.

Exposures in any individual case are influenced by many variables. These include, but are not limited to, the work being done, the particular method by which the work is done, ventilation (mechanical or natural), air flow patterns and characteristics, types of asbestos-containing products, proximity to the work, duration of the work, and duration of fiber settling times. Given these variables, it is logical that an individual's exposure profile may have a broad range for any given time period or job, and certainly for a career. Indeed, the fact that the average exposure for a particular trade or job may be low does not mean that the exposure was low for every worker in that trade or for every worker doing a particular task. Historic and contemporary data confirm this variability.

For industrial hygiene purposes, ranges are often more useful in understanding exposure than are averages. Air samples are integrated over the time periods of the individual samples, so there can be a range of exposure within each individual air sample that is unknown. For example, if an air sample is taken for 4 hours (240 minutes) and the reported result is 1.0 f/cm^3, that number could represent 30 minutes at 5.0 f/cm^3 (500% of the reported result) and 210 minutes at 0.4 f/cm^3 (40% of the reported result). The possibilities for the range of exposures are many for every air sample. Instantaneous, real time measurements specific to asbestos were not, and are not, done. Hence, exposure is affected by the workplace variables mentioned above, and the assessment of exposure is affected by the measurement techniques themselves. The full range of exposures even for a given workplace may not be known if both the highest and lowest concentrations were not measured, and even if the extremes were measured the data are subject to the limitations of the integrated sampling methodology. The variables in the workplace and limitations in the sampling methodology must be understood to prevent bias in interpretation of data and studies.

Historical exposure data are limited in quantity and scope. It is unreasonable to assert that such historical data, simulation data, etc. can only be reliable for estimating exposures that match in every detail the historical events, the simulations, etc. It is standard industrial hygiene practice to consider, with appropriate care, all data which may have bearing on a worker’s exposure. If industrial hygiene were limited to estimating exposures only where historical data existed as an exact match for the situation under assessment, there would be no meaningful and practical way to predict average exposures and/or ranges of exposures for the boundless variety of work places, work practices, and products in commerce today and historically. Without exposure estimates (both retrospective and prospective), health effects could not be related to workplace conditions, adequate exposure limits could not be established, and epidemiology studies would have insufficient foundation related to environmental conditions. This situation would preclude adequate worker protection and make workers “canaries” like those birds used in coal mines in times past.

3. Regulations and Literature

In 1971, the US Occupational Safety & Health Agency (OSHA) published its first asbestos regulation. In 1971, the US Environmental Protection Agency (EPA) listed asbestos as a hazardous air pollutant.

OSHA's first asbestos exposure standard in 1971, was 5 fibers per cubic centimeter of air (f/cc). The permissible exposure limit (PEL) has been reduced several times since to the current limit of 0.1 f/cc for an 8-hr time weighted average (TWA) and 1.0 f/cc over a 30 minute sampling time (Excursion Limit). Even this current PEL is not considered by OSHA to be fully protective and is still considered "a significant risk." (OSHA FR, 1994) OSHA regulates all forms of asbestos minerals (chrysotile, amosite, etc.) in the same manner because all types are known to cause disease, and the EPA also regulates all asbestos types in the same way.

The American Conference of Governmental Industrial Hygienists (ACGIH) in 1946 published its recommended exposure standard for asbestos. The standard was called a maximum allowable concentration (MAC) and was set at 5 million particles per cubic foot (mppcf) as an 8-hr TWA. (ACGIH TLV, 1946-1991) This measurement was by use of an impinger, and the analytical result was reported as the number of counted dust particles, per volume of air, collected in the impinger. The adequacy of the ACGIH MAC, which remained at 5 mppcf through 1973, was called into question in the literature in 1964. (Marr, 1964) In 1968, two published articles concluded that the MAC was too high. (Balzer, Environment, 1968) (Balzer, Industrial Hygiene, 1968) The ACGIH standard, which is now called the threshold limit value (TLV), has been reduced many times since and is currently at 0.1 f/cc as an 8-hr TWA. This measurement is specific to fibers, rather than all dust; however, the technique does not distinguish asbestos from non-asbestos fibers. The ACGIH definition of the TLV is "the time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that ***nearly all*** workers may be repeatedly exposed, day after day, without adverse effect." {emphasis added} (ACGIH 2006)

The EPA recognizes the concept of friability relative to the exposure risk associated with in-place asbestos-containing materials (ACMs). The agency's regulations for demolition and renovation require methods to control the release of fibers to the environment when ACMs to be disturbed are friable in-place and when ACMs which are not friable in-place will be rendered friable by the intended disturbance. ACM will release asbestos fibers into the air when it "…has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or, if applicable, which has delaminated such that its bond to the substrate (adhesion) is inadequate or which for any other reason lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM." (EPA, How to Manage, 1996) {ACBM= asbestos-containing building material}

4. Airborne Asbestos Hazard

Industrial hygienists use many techniques to assess exposure when little or no data exist for a given situation or worker. Conclusions may be drawn from data in the literature if conditions have sufficient similarity to the case of interest. Simulations are reliable for estimating exposure. (DiNardi, 2003) These data sources can be used to establish a likely range of exposures and probable average. For a given worker, however, the actual exposures at the extremes may be more or less than studies and literature indicate. General conclusions about exposures of a given worker population may not be accurate for an individual worker.

Industrial hygienists also may use retrospective exposure modeling for a given situation where actual data do not exist. This mathematical approach requires the use of many assumptions about what actually happened in the workplace and must also rely on studies and/or data collected under similar circumstances.

As noted above, OSHA does not consider the current PEL's to be fully protective. "OSHA's risk assessment also showed that reducing exposure to 0.1 f/cc would further reduce, but not

eliminate, significant risk." (OSHA FR, 1994) "No safe limit or 'threshold' of exposure is known. Any exposure to asbestos carries some risk to health, and people exposed to low levels of asbestos for a very brief period have later contracted mesothelioma." (EPA, 1980) Various cancers, including mesothelioma, are known to be caused by asbestos at very low lifetime doses. (Hillerdahl, 1999) (Goldberg, 2005) (Rodelsperger, 2001) (Iwatsubo, 1998) In a review from Dodson, "[t]he WHO stated that '[T]he human evidence has not demonstrated that there is a threshold exposure level for lung cancer or mesothelioma, below which exposure to asbestos dust would not be free of hazard to health.' The International Programme for Chemical Safety (IPCS) has reiterated this position." (Dodson, 2006) Also, "…exposure levels below those allowed for asbestos workers, the risk of asbestosis is negligible. Some scarring of lung tissue may appear on X-rays after many years of low exposure, but no impairment of respiratory function is likely to occur. **However**, the incidence of lung cancer and mesothelioma exceeds baseline rates even at very low exposure levels." (USEPA, 1983) {emphasis added} "While lowering exposure lowers risk, there is no known level of exposure to asbestos below which health effects do not occur…Mesothelioma is a type of fatal cancer of the lining of the chest or abdominal cavity. It can be caused by very low exposures to asbestos. This cancer has occurred among brake mechanics their wives and their children." (EPA, Brake Mechanics, 1986) The WHO concludes there is no threshold exposure level below which exposure to asbestos dust would be free of hazard to health. (IPCS, WHO, 1998) (WHO, 2006) In a 1991 joint EPA and National Institute of Occupational Safety and Health (NIOSH) document, "NIOSH contends that there is no safe airborne fiber concentration for asbestos. NIOSH therefore believes that any detectable concentration of asbestos in the workplace warrants further evaluation and, if necessary, the implementation of measures to reduce exposures." (EPA, Building Air, 1991) "Avoiding unnecessary exposure to asbestos is prudent." (EPA, Guidance for controlling, 1985) "The results of numerous measurements indicate that average concentrations of asbestos in ambient outdoor air are within the range of 10^{-8}– 10^{-4} PCM f/mL..." (ATSDR, 2001) It is my opinion that there is no basis for accepting any workplace or non-occupational exposure to asbestos above ambient background as "safe."

The hazard of workplace dust, including asbestos, has been recognized since the 1930s, and engineering controls, proper exhaust ventilation, and respirator protection were recommended. National Safety News, August 1933, The Mechanical Control of Occupational Diseases, David S. Beyer, states that "[w]hen the subject of dust is mentioned most of us probably think of visible particles. In fact, much of the dust removal work, even by companies specializing along this line in the past has been directed at the form of dust…Medical research has shown us, however, that dust that is most dangerous through its deep into the lungs is so small that the individual particles are invisible and can only be seen by the naked eye if they are gathered in a dense cloud, which may have the appearance of a gray fog…In general, the most reliable way to correct a dust hazard is to install exhaust equipment that will capture the dust at the point where it is generated." TRANSACTIONS, 26th National Safety Congress, 1937: What Industrial Dusts Are Harmful? Why? Dr. R.R. Sayers, states that "Dust Control. Engineering and medical control are the two most important factors in combating the industrial dust hazard, and are to a large extent complementary…Dust may be entrapped at its source by suction devices and thus removed and collected…Generally speaking, the exhaust ventilation method, where applicable, is to be preferred in controlling a dust hazard…Sometimes a dusty process can be completely enclosed in a sealed room or compartment…A great deal of attention has been given the subject of individual protection from dust, and there are many types of respiratory protective devices now available. These are generally of two types: those which provide fresh air from an uncontaminated source and those which rely upon a filtering medium for removing dust from the air breathed. Where the use of such a device is indicated, only one of the types approved by the U.S. Bureau of Mines should be used. As a rule, it may be said that masks, respirators, or other such protective device should be used only where exposure to the dust is intermittent and brief, or where some unusual conditions makes a more adequate dust control impracticable." TRANSACTIONS, 32nd National Safety Congress, Volume II, 1943, The Control of Fumes in Shipyards, William E. Lawrence, states that "[t]he use of water repellent asbestos insulation has recently replaced some types of material formerly used in ship work. For protection against dust or possible asbestosis from such material, it is recommended that both on ships and in shops, or where the materials is prepared, it be dampened and that dust respirators be worn, also that special ventilation be provided. Periodic medical examination of those exposed to such hazards is also necessary." (National Safety

Council -Asbestos -1934-1949)

I believe that any exposure above ambient background is to be avoided and any such exposure may contribute to disease in some individuals. The human respiratory system is not selective as to the source (product) of airborne asbestos during inhalation; therefore, if there actually is a lifetime dose-response relationship for some diseases, any asbestos body burden added by workplace exposure above ambient contributes to risk of disease, regardless of the product types, manufacturers, worksites, or exposure averages. If no safe threshold exists for some asbestos-related conditions, such as mesothelioma, then the conclusion is the same.

5. Asbestos-containing Dust and Resuspension

Depending on the percentage of asbestos in the product and the force imparted to it, resultant dust will contain varying levels of asbestos. If a dust cloud is visible to the unaided eye, then the airborne concentration is well above 5 mppcf. (Dement Deposition, February 1998) Conversely, airborne asbestos concentrations can be very high even if dust is not visible in the air. "Usually the dust concentration must be from 8-10 million particles per cubic foot before its presence is visible in average lighting conditions." (Calidria, 1968) Like most other breathable hazards, concentrations of airborne asbestos can be decreased or increased due to particular prevailing conditions such as presence of ventilation, airflow, atmospheric conditions, amount of asbestos in the product used or disturbed, presence of other co-workers pursuing the same asbestos-related activity, workers' proximity to asbestos-related activity, and the sometimes numerous and different work practice approaches to the same asbestos-related activity.

The presence of visible dust released from an asbestos containing product represents an asbestos exposure that is at least hundreds of times above background/ambient exposure levels (background level being 0.0004 f/cc.) The results of numerous measurements indicate that average concentrations of asbestos in ambient outdoor air are within the range of 10^{-8}– 10^{-4} PCM f/mL..." (ATSDR, 2001) It is our opinion that there is no basis for accepting any workplace or non-occupational exposure to asbestos above ambient background as "safe." According to a

review by Dodson et al., the point at which visible dust would have been visible in mppcf ranged from 10 - 40 depending on the work conditions at hand. (Dodson, 2006) “Usually the dust concentration must be from 8-10 million particles per cubic foot before its presence is visible in average lighting conditions.” (Calidria, 1968) “Older occupational studies measured dust exposure in units of million particles per cubic foot (mppcf). This method did not distinguish fibrous from nonfibrous particles and used relatively low magnification, so only the largest particles and fibers were detectable. When a more accurate value is not available, it has been assumed that a concentration of 1 mppcf is equal to 3 PCM f/mL.” (ATSDR, 2001) Therefore, at a point at which a person would have visibly seen dust arising from his activities with asbestos-containing products (8 – 40 mppcf), he would have potentially been exposed to 24 f/cc to 120 f/cc.

According to the EPA, “The aerodynamic behavior of fibrous-shaped aerosol particles is governed by the interaction of opposing forces: a driving force such as is caused by gravitational acceleration, and the viscous resistant of the gaseous medium within which the particle moves.” (EPA, ACM in Buildings, 1978) Asbestos fibers are very small and possess aerodynamic qualities such that the fibers, once released to the air, may remain suspended for hours, and hence remain in the breathing zone of workers and bystanders. “It is of interest to note that for fibers whose diameter is of the order of 0.1μm, gravitational sedimentation occurs at the rate of only a few centimeters per hour, even though their length may be as much as 100μm.” (EPA, ACM in Buildings, 1978) The fibers may be carried by air currents to great distances from the original point of release. Fibers may eventually settle onto surfaces in the work area (either near or far from the release point, depending on air movement), and can be resuspended into the air when the surfaces onto which they settled are disturbed. This repeatable process can lead to very high airborne asbestos exposures. (EPA, ACM in Buildings, 1978) (Millette and Hays, Settled Asbestos Dust, 1994)

There are no regulated limits for asbestos in settled dust. The potential for settled dust to create unacceptable exposures to airborne asbestos, however, is recognized by both the U.S. EPA and the U.S. OSHA in their respective regulations, guidance documents, and interpretations. Asbestos

is considered an inhalation hazard. Asbestos structures which are airborne in the breathing zone can be inhaled. Important exposure sources include the mining and milling of asbestos minerals, manufacture of asbestos-containing products, handling and shipping of those products, installation of ACMs, removal of ACMs, and disturbance of ACMs during operations and maintenance activities. Asbestos fibers and structures in settled dust can become airborne when the dust is disturbed and thereby pose an inhalation hazard. The resulting air concentrations can be significant. I believe one of the most important sources of exposure related to in-place ACMs is disturbance of asbestos-containing settled dust.

The literature is flush with the hazard potential from asbestos dust. (Bonsib, 1937) (Fleischer, 1946) (Harries, 1968) (Harries, 1971) (Sawyer, 1977) (Baldwin, 1982) (Keyes, 1991) (Singer, 1992) (Keyes, 1992) (Ewing, 1992) (Ewing, 1993) (Keyes, 1994) (Hatfield, 1997) (Dodson, 2006) (EPA, 1979) (Doll, 1955) (Dreesen, 1938) (Asbestosis, 1949, p. 1219) (National Safety Council, 1934-1949)

6. Bystander Exposure

"Bystander" is used in this report to mean any people who are in the vicinity of asbestos related work but not actually themselves manipulating the asbestos-containing products. These can be persons of other construction trades, laborers, vendors, delivery people, equipment operators, industrial process operators, managers, casual observers, etc. Exposure to airborne asbestos occurs to workers who repair, remove, or otherwise disturb asbestos-containing materials. Exposure also occurs to workers who clean-up asbestos debris and dust. While all of these activities are in progress, exposure to airborne fibers occurs to other people (bystanders) in the immediate vicinity and in some circumstances to people distant from the activities.

People who were not directly involved in the manufacture, use, installation, repair, and removal of asbestos-containing products can be at risk. In the repair, renovation, construction, power production and shipbuilding industries it is very common for multiple trades to be working side by side, or in an overlapping manner. This is referred to loosely as sequencing. For example,

with regard to installation of asbestos-containing products, it would not be uncommon to see pipe fitters working near pipe insulators; it also would not be uncommon for white collar workers to episodically pass through this aforementioned area as a supervisor. In the course of a blue collar worker's career it would not be uncommon for him/her to be exposed to varying degrees of airborne asbestos fibers, especially during the height of asbestos use, during the 1950's, 1960's, and early 1970's. (ATSDR, 2001) (Harries, 1968) "First impressions of the problem would suggest that only those men continuously working with asbestos are at risk. In the dockyards these men would be the mattress workers, laggers, sailmakers working with asbestos cloth, asbestos sprayers, and strippers, and storeman. Experience has shown, and further consideration of the industry and processes should suggest, that many other men have been at risk." In this same 1968 study, asbestosis was discovered in other job classifications like electrical fitter, engineer, and welder. Harries "attempted to show that as an industry the Navy uses large amounts of many different products containing asbestos in varied and difficult working conditions. The work often gives rise to high dust concentrations and many people working near the different processes may be exposed to the hazard. We know that men other than those working directly with asbestos are contracting asbestosis." (Harries, 1968) The scientific literature reveals significant exposure to bystanders. (Hillerdahl, 1999), (Harries, 1971) (Hatfield, Insulating Cement, 1999) (Hatfield, Audicote, 1998) (Selikoff, 1972) (Hatfield, US Gypsum Acoustical, 1997) (Egan, Monokote, 1970) (Fischbein, Drywall, 1979) (Keyes, Baseline, 1994) (Keyes, Re-entrainment, 1992) (Keyes, Cable Installation, 1991) (Ewing, Cable Installation, 1993) (Ewing, Take Home, 2007) (Ewing, Boiler Room, 1992) (Kilburn, 1985) (Gorman, 2004) (Lerman, 1990) (Lilienfeld, 1991) (Millette, Releasability, 1995) (Millette, Gaskets and Packing, Chapter 6, 1996) (McKinnery, 1992) (Grandjean, 1986) (Dodson, 2006) Exposure to bystanders can be as high as to people actually doing the work with ACMs (asbestos-containing materials). (Harries, 1971) (Selikoff, 1972) (Keyes, 1992) (Cross, 1971)

"The population at risk includes not only those engaged in the manufacture and use of asbestos products, but also bystanders and others limited to neighborhood or familial exposures." (Sawyer, 1977) "While most studies of asbestos and the development of human disease have focused on individuals occupationally exposed, there is an increasing body of evidence that non-occupational

exposure, usually called environmental or bystander exposure, can lead to the development of asbestos-related disease." (Dodson, 2006) Grandjean and Bach state that "[i]ndirect exposure may occur at work when adjacent workers are exposed to hazards originating from fellow workers' activities. Indirect exposures of household members may occur when hazardous substances are carried home (e.g., in the clothing)." (Grandjean, 1986) According to Goldberg, "[c]oncern used to be focused on the occupational environment, but it is now recognized that asbestos fibers are widely distributed in the general environment. Persons can be exposed to asbestos in different non-occupational circumstances: living with asbestos workers, with regular exposure to soiled work clothes brought home; environmental exposure in the neighborhood of industrial sources (asbestos mines and mills, asbestos processing plants); passive exposure in buildings containing asbestos…" (Goldberg, 2005) In 1979, Selikoff comments on a previous study from 1976 stating that "[a] source of home contamination in individual exposure was postulated as resulting from dust adhering to shoes, hair, and work clothes brought home for laundering. Change rooms and company laundered coveralls were not available at this plant." This 1979 study also notes that "[t]he observation that nearly one-half of the wives examined had abnormal x-rays is consistent with the hypothesis that the wives would have been most heavily exposed because they were responsible for the laundering of work clothes and resided in the household for the longest period of time." (Selikoff, 1979) Chen states that "[w]e report this case to emphasize the association of malignant mesothelioma with a very limited exposure to asbestos…" (Chen, 1978) According to ASTDR, "[y]ou can bring asbestos home in the dust on your hands or clothes if you work in the mining or processing of minerals that contain asbestos, in asbestos removal, or in buildings with damaged or deteriorating asbestos." (ATSDR, 2001) Edge states that "[m]alignant mesothelioma may follow relatively low and sometimes brief exposure to asbestos dust." (Edge, 1978) Hillerdahl states that "[o]rdinary vacuum cleaning is not effective in removing asbestos fibres, which can remain for years in the house and be airborne again whenever disturbed." (Hillerdahl, 1999) Regarding the resuspension of asbestos dust, the movement of a worker in a small unventilated room while wearing a laboratory coat contaminated with Marinite dust resulted in airborne asbestos concentrations ranging from 3.3 to 24.0 fibres/cm^3 (n=3). (Carter, 1970)

This theme of household or familial asbestos exposure from asbestos contaminated work clothes is recalled in several other instances. (Bianchi 2001) (Lerman, 1990) (Ferrante, 2007) (Huncharek, 1989) (EPA, 1990) (Anderson, 1976) (Newhouse, 1965) (NIOSH, 1995) (Ewing, Take Home, 2007) (Sawyer, 1977) (Revell, 2002)

7. Fiber Type and Fiber Size

Fiber Type

ATSDR states that "All forms of asbestos are hazardous, and all can cause cancer, but amphibole forms of asbestos are considered to be **somewhat** more hazardous to health than chrysotile."[1] {emphasis added} Grace experts contend that fiber type and length are extremely important with regard to potential exposure risk. In discussions about fiber type, OSHA states that "[a]fter a comprehensive review of the evidence submitted concerning the validity of the 1984 risk assessment, OSHA has determined that it will continue to rely on the earlier analysis. The Agency believes that the studies used to derive risk estimates remain valid and reliable, and that OSHA's decision to not separate fiber types for purposes of risk analysis is neither scientifically nor regulatorily incorrect. There are at least three reasons for OSHA's decision not to separate fiber types.

A. First, OSHA believes that the evidence in the record supports similar potency for chrysotile and amphiboles with regard to lung cancer and asbestosis. The evidence submitted in support of the claim that chrysotile asbestos is less toxic than other asbestos fiber types is related primarily to mesothelioma. This evidence is unpersuasive, and it provides an insufficient basis upon which to regulate that fiber type less stringently.

B. Second, as stated in the 1986 asbestos standard, even if OSHA were to accept the premise (which it does not), that chrysotile may present a lower cancer risk than other asbestos fiber types, occupational exposure to chrysotile asbestos still presents a significant risk of disease at the revised PEL (See 51 FR 22649, 22652). In particular, asbestosis, the disabling and often fatal

fibrosis of the deep portions of the lung, is caused by exposure to all types of asbestos. The evidence on this is strong and no new information has been presented to contradict this. As stated above, OSHA estimated asbestosis risks at 0.2 f/cc exposures as an unacceptably high 5 cases per 1000 workers. Thus, asbestosis risks alone justify the regulation for chrysotile.

C. Third, the record shows that employees are likely to be exposed to mixed fiber types at most construction and shipyard industry worksites most of the time. Assigning a higher PEL to chrysotile would present the Agency and employers with analytical difficulties in separately monitoring exposures to different fiber types. Thus, regulating different fiber types at differing levels, would require more monitoring all the time and would produce limited benefits (51 FR 22682)." (OSHA, 1994)

In a letter from the WHO, it is clearly stated that "all types of asbestos cause asbestosis, mesothelioma, and lung cancer." (WHO, 2006) According to Dr. Richard Lemen, "We are at a point in the history of asbestos usage where chrysotile is the predominant type asbestos produced and consumed in the world today; it constituted about 98.5% of US consumption in 1992…A review of 92 consecutive cases of mesothelioma found that even while only 28.3% of the asbestos fiber type in the lung was chrysotile, it was the major fiber type identified in the mesothelial tissue itself. These findings further suggest that lung burden analysis for determining fiber type in mesothelioma etiology may not be appropriate and that determining predominate fiber type in the mesothelial tissue is the more rational determinant." (Lemen, 2001) Nicholson concludes, "[f]rom studies in the United States and Great Britain, chrysotile has been shown to increase the risk of lung cancer and to produce mesothelioma in exposed workers." (Nicholson, 2001) Other literature express this notion. (Smith, 1996) (Beddington, 2001) (Stayner, 1996) (Kahansly, 2001) (Kanarek, 2011)

Fiber Size

According to Dodson and his research, the regulated fiber size (≥ 5μm) "selection criteria were based on 'practicality and theoretical considerations' rather than having a target of a 'more toxic'

population of fibers." (Dodson, 2006) According to Sawyer and his research, the "…counting of only those fibers 5μm or longer is inappropriate. Airborne fiber sizes range from hundreds of microns to fibrils of submicron dimensions, and the size distribution of asbestos particles in human tissues studied by electron microscopy is in most part less than 5 μm." (Sawyer, 1977) In a 2001 study, researchers conducted fiber burden analysis in a series of individuals with mesothelioma who were 50 yr or less of age at time of diagnosis. They concluded that "[s]horter fibres were more abundant than longer fibres, and high concentrations of all fibre lengths tended to occur together." (McDonald, 2001) Dodson agrees that "…inhaled asbestos fibers cause asbestos-related disease and most frequently consist of a mixture of asbestos types and sizes." (Dodson, 2006) According to Suzuki et al., the majority of the fibers in the lung and the mesothelial tumor tissue were less than 5μm in length. (Suzuki, 2002) Suzuki later states "…that contrary to the Stanton hypothesis, short, thin, asbestos fibers appear to contribute to the causation of human malignant mesothelioma." (Suzuki, 2005) Dodson states that "[t]he fact that short fibers (< 5μm) have been shown to produce toxic effects in macrophages in vitro and to be fibrogenic tumorigenic in animals in vitro, and that they reach the site of mesothelioma development support the inappropriateness of discounting their role in asbestos-related disease as has been done…" (Dodson, 2006)

8. Mr. Yates Work History

Mr. Yates was born on August 22, 1938, and he was 74 years old at the time of the deposition (Video Deposition 021313, 7:20-22). Mr. Yates was giving this deposition because he had been diagnosed with mesothelioma (Video Deposition 021313, 8:21-24).

Prior to joining the Navy, Mr. Yates worked in construction (Video Deposition 021313, 55:14-17). Regarding the type of construction work he was involved in, Mr. Yates stated, "I want to say '53. I was 15 years old at the time. I remember that because I had to get a worker's permit to be able to work because I wasn't 16 years old. And I worked for Muirhead Construction in Durham…Well, they built the East Campus at Duke University. They were just a contractor, built buildings…They did the construction of steel, the beams and bar joists and the sheet metal, that

sort of stuff, the skeleton" (Video Deposition 021313, 55:18-56:11). Regarding whether this was the only time he worked for Muirhead Construction, Mr. Yates stated, "No. I worked for him two years later in Raleigh at WakeMed when they started building WakeMed" (Video Deposition 021313, 64:20-24). This work was "two years later…approximately 1955" (Video Deposition 021313, 65:2-4).

Mr. Yates also worked at some gas stations, and "[o]ne of them was Upchurch Esso in Raleigh and the other was Daniels Esso, and it was also in Raleigh but it was out near the airport…It was in the summer generally and at night for Upchurch…I was in high school" (Video Deposition 021313, 68:24-69). Mr. Yates agreed that his job duties were "the same at each one of the Esso gas stations" (Video Deposition 021313, 70:4-6). Mr. Yates worked at the Esso gas stations in 1956 and 1957 (Video Deposition 021313, 70:8-16). Mr. Yates agreed that when he worked at the Esso gas stations in the summertime, it was full-time work, and he worked six days a week "[g]enerally from 8:00 until 6:00…Well, sometimes the hours would vary. And if I went to work from school when school was in, then I would go in the afternoon and work till 10:00 at night" (Video Deposition 021313, 70:17-71:10). Regarding his job title and job duties at the Esso gas stations, Mr. Yates stated, "Just attendant…Pumping gas, washing windshields, helping the mechanics, taking parts to the mechanics, washing cars, putting in oil, washing windshields. Just general old fashioned service station work" (Video Deposition 021313, 71:13-20).

Mr. Yates stated that he graduated from Cary High School in 1957 (Video Deposition 021313, 91:7-10).

Mr. Yates stated that he "joined the Navy in February of 1957, the Navy Reserve," and he went on active duty "[i]n September of 1958 -- well, August of 1958, I was called and got a letter saying report no later than September 3, 1958 to Great Lakes Naval Training Center. We had been activated" (Video Deposition 021313, 29:9-24). Mr. Yates stated that his "first duty station was at an underwater station, Gould Island in Newport, Rhode Island…November of 1958…Approximately 18 months" (Video Deposition 021313, 30:18-31:2). Mr. Yates was then "transferred to the USS Jonas Ingram in Mayport, Florida…About six, eight months" (Video

Deposition 021313, 32:25-33:6). Mr. Yates was then “transferred on the USS Clearance K. Bronson and we took the ship to Orange, Texas for decommissioning…Four or five months” (Video Deposition 021313, 34:2-10). Mr. Yates stated that he left the Navy “[i]n 1960, July…Well, in July, I got a -- I was released from active duty and then I had four more years of obligation. At the end of that time, I did get an honorable discharge, yes” (Video Deposition 021313, 38:8-15).

After Mr. Yates left the Navy, the next job where he believes he worked with asbestos was at “Sanders Motor Company, the Ford dealer in Raleigh, in the parts department…From I think 1960 on into ’61, approximately six months” (Video Deposition 021313, 38:19-39:2).

Mr. Yates stated that he “went to work for the North Carolina Equipment Depot…[in]…‘61 but maybe ‘62. It was ‘61” (Video Deposition 021313, 80:10-13). Mr. Yates worked at North Carolina Equipment Depot for “[t]wo years,” and “[c]lerk was the title we got” (Video Deposition 021313, 80:14-18). Mr. Yates worked “[f]rom 7 to 4,” five days a week (Video Deposition 021313, 80:19-22).

Regarding what he did after he left North Carolina Equipment Depot, Mr. Yates stated, “I left the equipment depot and went to work for Mutual of New York Insurance Company. That was until 1963, and I left them. I was a field underwriter for Mutual of New York…A year or so, 18 months” (Discovery Deposition 021313, 45:6-20).

Mr. Yates stated that he left Mutual of New York because he “had an opportunity to go with a food manufacturing company, American Home Foods. It was the Chef Boyardee people. Probably more familiar…Started out in sales and moved into management…1963, I recall…It was either February or October. I don’t remember. I think it was October” (Discovery Deposition 021313, 46:15-47:3). Mr. Yates stated the he went into management “[i]n, let’s see, about ‘67” (Discovery Deposition 021313, 47:10-11). Mr. Yates stated that he worked for American Home Foods for 20 years, “So ’63 to ‘83” (Discovery Deposition 021313, 47:21-24).

Mr. Yates next went to work at Stokely USA, Inc. in (Discovery Deposition 021313, 48:11-16). Mr. Yates started working for Stokely USA, Inc. in 1983, and worked there of 15 years until 1998 (Discovery Deposition 021313, 48:20-25).

Mr. Yates stated that he has a commercial aircraft license, which he got in 1970, and a flight instructor rating, which he got "[a]round 1971" (Video Deposition 021313, 87:19-88:3). Regarding his work for Triple W Airport, Mr. Yates stated, "I got my flight instructor rating in '72, but Triple W was -- let me make this clear. I did not work for Triple W. I was an independent contractor…I had my own students and my own thing and then we would -- I was authorized to rent airplanes if the student couldn't. You know, after they've flown awhile, they could rent airplanes. But I was not employed by Triple W" (Discovery Deposition 021313, 50:21-51:10). The first year Mr. Yates "worked as an independent contractor out of Triple W Airport…[was]…maybe 2000," and he "last did that in 2008" (Discovery Deposition 021313, 51:11-18).

9. Asbestos Exposure at the Esso Gas Stations

Regarding what he did to help the mechanics at the Esso Gas Stations, Mr. Yates stated, "with the mechanics, they did muffler work, tune-ups, brake work, that sort of stuff. But generally it was mufflers, brakes and tune-ups was the major part of it. It wasn't overhauling engines and that sort of stuff" (Video Deposition 021313, 72:2-10). Regarding the size of the Esso gas stations, Mr. Yates stated, "Upchurch was a three-bay station. Two bays for mechanics and one bay had a little automatic washer, car wash…Daniels was just one bay" (Video Deposition 021313, 72:11-18). Regarding how many days a week he worked "at either of the Esso places," Mr. Yates stated, "I worked at Avery Upchurch's six days. Some of that was in the summer. The Exxon was just more on a temporary basis. I mean the Daniels…Not every day" (Discovery Deposition 021313, 116:20-117:1). Regarding "how many hours per week…[he]…would have worked at either location during this time frame," Mr. Yates stated, "Probably 40" (Discovery Deposition 021313, 117:22-25).

Regarding how many brake jobs were performed at the Upchurch Esso station, Mr. Yates stated, "They would usually do three or four jobs a week. You know, some weeks they may to two or three a day and for a total of maybe a dozen brake jobs. The next week they may not do but one. So it was no set number" (Video Deposition 021313, 72:20-73:1). Regarding how he would "assist a mechanic with respect to a brake job," Mr. Yates stated, "Just a helper, getting the parts and delivering the parts to him, you know, handing him tools and handing him brakes or brake linings or whatever, you know, just standing there. He would say hand me this, hand me that. We just did whatever he needed doing, and sometimes you would have to hold something because they didn't have all the specialized tools at that time" (Video Deposition 021313, 73:4-13). Mr. Yates agreed that he would "be working shoulder to shoulder…kind of side by side the mechanic when he was doing his brake work" (Video Deposition 021313, 73:14-19). Regarding "the process by which the mechanic would replace a brake," Mr. Yates stated, "The same. Pulling the tire and rim and hub and loosening the spring that held them together and taking them off. And in the Esso station, they used -- a lot of times they would use air to clean it because they had an air source there and it would make it a lot faster…Instead of using the brush to clean out the drums, they were using the high-pressure air to blow all that dust out...Brake dust" (Video Deposition 021313, 73:20-74:13). Regarding what was in the air "when the pressurized air hose was used to remove the brake dust," Mr. Yates stated, "It was full of dust…Very visible," and he breathed the dust in (Video Deposition 021313, 74:14-21). Regarding the mechanics next step "after they used the pressurized air…in the process to installing the new brake," Mr. Yates stated, "They, again, sanded the new brake some, wiped the drum clean with a solvent so it would be perfectly clean, and then just reverse the process to put the brake back on" (Video Deposition 021313, 74:22-75:3). Mr. Yates stated that the mechanics used sandpaper to sand the brake lining (Video Deposition 021313, 75:4-10). Regarding what was in the air "when the mechanics were sanding the lining of the new brakes," Mr. Yates stated, "There was dust in the air," the dust was visible, and he breathed the dust in (Video Deposition 021313, 75:11-19). Regarding how long it would "take the mechanics to sand the linings of the new brakes," Mr. Yates stated, "Just a couple of minutes. And then before they put the hubs back on, they would blow it out one more time generally to make sure all the dust was clear" (Video Deposition 021313, 75:20-76:1). Regarding "how many brakes would be involved within those three to four [brake] jobs on average," Mr.

Yates stated, “Well, there would be two to four wheels. Sometimes they did all four. Sometimes they would just do the front. Very rarely did you ever have to do the back because they wore less” (Video Deposition 021313, 76:2-9). Mr. Yates stated that if they were doing the two front wheels, they were doing “[f]our brake shoes” (Video Deposition 021313, 76:10-12). Regarding whether he was “involved in the actual assisting of the mechanics in performing this brake work,” Mr. Yates stated, “On occasion…It would vary. Probably half of them anyway. But we had other responsibilities, you know, like pumping gas and doing that other stuff. But then when we would finish that, we would go back to help them. So I would say at least half” (Video Deposition 021313, 76:14-77:1). Regarding what “would have to be done to the floor after the mechanics performed the brake work,” Mr. Yates stated, “It would always have to be swept. The owner was very particular about that…Well, when the brakes were changed, it was an accumulation of brake dust because sometimes they may do several jobs, two or three jobs, without sweeping” (Video Deposition 021313, 77:2-13). Regarding “who was responsible for sweeping the dust from the floor after the mechanics performed their brake work,” Mr. Yates stated, “Well, the mechanic was supposed to but he seldom did. So we wound up having to do that. And I say “we.” It was a couple of us that worked there, so generally both of us would get a broom because it was two bays. And this would be close to 10:00 at night, so we were ready to -- near the time to get off. You didn’t do it till it was time to close. So we would try to hurry up and the two of us would do it, but it took a while because it was a lot of dust…Usually around 20 minutes or so per bay” (Video Deposition 021313, 77:14-78:5). Regarding what he saw in the air when he was sweeping, Mr. Yates stated, “Dust,” the dust was visible, and he believes he breathed the dust in (Video Deposition 021313, 78:6-13). Mr. Yates stated that the brakes that were used at the Esso gas stations were Bendix (Video Deposition 021313, 78:14:17).

Regarding “how many brake jobs would have been done at Daniels in a week or month,” Mr. Yates stated, “At Daniels, I would say probably half a dozen from what I know. I wasn’t there all the time but from what I remember. That was one of their big repair jobs was brakes…No. In a week. They could do three a day easy or four a day, so that’s not many” (Discovery Deposition 021313, 121:19-122:4). Regarding “the number of times that…[he]…would have been present at

Daniels in an average week during a brake job," Mr. Yates stated, "Probably half a dozen" (Discovery Deposition 021313, 122:11-14).

10. Asbestos Exposure from Personal Vehicles

Mr. Yates "thinks" that the first time that he worked on his own vehicle was "[a]round 1956 when I got this '50 model ford" (Video Deposition 021313, 9:16-21). Mr. Yates stated that he purchased this Ford vehicle in 1956 and kept the car for four years (Video Deposition 021313, 10:12-16). Regarding the type of work that he did on this Ford, Mr. Yates stated, "Brakes, mufflers, exhaust manifolds. I had to replace gaskets on those, water pump gaskets, you know, tune-up and that sort of stuff" (Video Deposition 021313, 10:17-21). Mr. Yates stated that he replaced the brakes "[o]n the [1950] Ford, a couple of times because of the mileage" (Video Deposition 021313, 10:23-11:2). Regarding the process of replacing the brakes on the Ford, Mr. Yates stated, "Well, you have to pull the tire and rim off and then you pull the brake -- the hub off so you can expose the lining. And then you have a tool that you release a spring and that releases the brake shoes and pull them out…Usually in my dad's garage. Car garage, not a shop" (Video Deposition 021313, 11:3-14). Mr. Yates stated that the brakes that he was working with "were Ford brakes from the local Ford dealer…These were drum brakes" (Video Deposition 021313, 11:15-21). Mr. Yates does not "know the maintenance that occurred on the vehicle" before he purchased it (Video Deposition 021313, 11:25-12:3). Regarding the process that he did after he had removed the brakes, Mr. Yates stated, "It had to be cleaned. I had a little -- they call it a brake brush, little round brush with stiff bristles that would clean the drum, clean the area so it would be fresh for the new brakes" (Video Deposition 021313, 12:4-13). Regarding "[h]ow long it would take for…[him]…to use this brush and clean out the brakes," Mr. Yates stated, "A few minutes, depending on how bad the brake dust was. You know, I had to clean it out and then wipe it from there and make sure all the residue was gone" (Video Deposition 021313, 12:21-13:2). Mr. Yates stated that he was cleaning out brake dust from "[t]he hub that the brake pressed against when it stopped the car and it fell down to the bottom and accumulated in the bottom" (Video Deposition 021313, 13:4-8). Regarding what was in the air when he cleaned out the brake drum with the brush, Mr. Yates stated, "Well, it filled air with the dust and of course I was there breathing the

dust," and he believes he breathed the dust in (Video Deposition 021313, 13:9-16). Mr. Yates agreed that when he was "using the brush to clean out the brake residue from the old brake," the dust was visible (Video Deposition 021313, 14:19-22). Regarding "the next step in replacing the brakes," Mr. Yates stated, "We would sand the new brakes slightly just to rough them up a little bit so they would give them more friction. Some of the old cars would wear. And instead of replacing the drum, you would sand the brakes and it gave it better friction, better stopping power" (Video Deposition 021313, 13:17-24). Mr. Yates stated that he was sanding "[t]he pad. Well, actually the lining, as we called it" with "[s]andpaper, light grit sandpaper" (Video Deposition 021313, 13:24-14:6). The sanding of the brake lining would take "[a] few minutes" (Video Deposition 021313, 14:7-9). Regarding what he saw while he was sanding the brake lining, Mr. Yates stated, "Well, there again, there was obviously dust from the brake," the dust was visible, and he breathed the dust in (Video Deposition 021313, 14:10-18). Mr. Yates stated that he purchased the new brakes "[f]rom Sanders Motor Company, Ford dealer in Raleigh…They were Ford brakes…Usually four to a box, one for each side of the car" (Video Deposition 021313, 14:23-15:9). Regarding how many brakes he would actually change when he did a brake job, Mr. Yates stated, "Well, each wheel had two brakes, two pads. So you would change anywhere from four to eight. Depends on whether you did the front and the back or not, but you always did at least four" (Video Deposition 021313, 15:13-20). Mr. Yates agreed that the process of "using the brush to clean out the brake shoe and then sanding of the brake lining" would be done on each brake that he installed (Video Deposition 021313, 15:21-16:1). Regarding what "happened to the dust that was from the brushing out of the brake shoe and the sanding of the brake lining," Mr. Yates stated, "It fell on the floor right there…Well, when I completed the brake job, I swept it up and got it out…Just a broom, straw broom" (Video Deposition 021313, 16:6-18). Regarding what was in the air when he was sweeping the dust up from the Ford brakes, Mr. Yates stated, "It was dusty all around," the dust was visible, and believes he breathed the dust in (Video Deposition 021313, 16:19-17:1). Regarding whether he got the dust on his hands, Mr. Yates stated, "Every time because you didn't wear gloves. You couldn't do the job with gloves on" (Video Deposition 021313, 17:2-6).

Mr. Yates stated that he purchased a 1957 Plymouth in 1960, and he replaced the brakes one time (Video Deposition 021313, 17:23-18:4). Mr. Yates stated that he did not know the maintenance history of the Plymouth when he purchased the vehicle (Video Deposition 021313, 18:16-19). The maintenance work he did on the Plymouth was the brakes (Video Deposition 021313, 19:19-21). He kept the Plymouth for 2 years (Video Deposition 021313, 19:22-23). He replaced the front brakes on the Plymouth (Video Deposition 021313, 20:2-4). Regarding the process of replacing the brakes on the Plymouth, Mr. Yates stated, "You remove the tire and rim and take off the unit to where you can take off the housing around the brake and get your tool, take the spring off and take the brake shoes off…Again, cleaning the drum with the same brush or with a similar brush that I used on the old Ford, just making sure that everything was clean and ready to put the new brakes back on" (Video Deposition 021313, 20:5-17). Regarding what was in the air when he was brushing off the brakes, Mr. Yates stated, "Well, there was dust that came from the brake obviously," the dust was visible, and he breathed the dust in (Video Deposition 021313, 20:18-25). Regarding his next step in replacing the brakes, Mr. Yates stated, "Well, I wiped the drum, wanted to make sure that it was clean, and then I would sandpaper that brake itself or the brake pads. You know, they were longer on these cars than they are now. And then we would reinstall them. Then I would reinstall them" (Video Deposition 021313, 21:1-9). Regarding what was in the air when he was sanding the brakes, Mr. Yates stated, "Well, dust came up," the dust was visible, and he breathed the dust in (Video Deposition 021313, 21:10-17). Regarding where he purchased the brakes for the Plymouth, Mr. Yates stated, "These brakes were Bendix brakes. They were bought at a place called Barnes Motor & Parts" (Video Deposition 021313, 21:18-21). Regarding how long it would take to brush out the brakes, Mr. Yates stated, "Just a few minutes, depending on how much dust was in there. Times would vary" and "to sand just one of the [Bendix] brakes," it would take "[a] minute or so" (Video Deposition 021313, 22:22-23:6). Mr. Yates agreed that there were "two brakes per wheel," and he "just changed the front brakes…So that would have been four brakes" (Video Deposition 021313, 23:7-14). Regarding how long it took for him "to perform this one brake job on the '57 Plymouth from start to finish," Mr. Yates stated, "Well, I'm not a pro. Probably a couple of hours at least, and hour or so on each side" (Discovery Deposition 021313, 112:1-5).

Regarding any other vehicles that he performed maintenance on, Mr. Yates stated, “Yes. My brother had a ‘51 Nash Ambassador that we -- well, I say we. I did it. He was standing over my shoulder. But I put the brakes on that with the same process we did the others” (Video Deposition 021313, 23:15-21). Regarding what year his “brother had this vehicle or that…[he]…performed the maintenance work on it,” Mr. Yates stated, “That was ‘57, ‘8. I can’t be exactly sure on that” (Video Deposition 021313, 23:23-24:2). Regarding the process that he “used in removing the brake on this Nash Ambassador,” Mr. Yates stated, “It was the same tire and rim. Take off the brake drum and take the spring off, take the linings out and start cleaning…Cleaning out the brake dust that was accumulated around the drum…A brush, wire brush” (Video Deposition 021313, 24:5-17). Mr. Yates stated that it took “[a] few minutes” to “use this brush to remove the brake dust from the drum” (Video Deposition 021313, 24:18-20). Regarding what was in the air when he cleaned the bakes, Mr. Yates stated, “It was -- the dust came up into the air. It was visible,” and he breathed the dust in (Video Deposition 021313, 24:21-25:1). Mr. Yates stated that he replaced the brakes on his “brother’s Nash Ambassador…Just one time. That was enough…Front brakes only” (Video Deposition 021313, 25:5-10). Mr. Yates purchased the brakes “from Barnes Motor & Parts…They were also Bendix (Video Deposition 021313, 25:11-16). Mr. Yates agreed that he did not know the maintenance history of the ‘51 Nash Ambassador (Discovery Deposition 021313, 113:13-16). Mr. Yates stated that he did this brake job in his father’s garage (Discovery Deposition 021313, 113:21-22).

Mr. Yates stated that he did “additional work besides brake work…On the Ford and the Nash Ambassador…I put manifold gaskets on the Ford and a water pump gasket” (Video Deposition 021313, 26:19-27:1). Regarding the manufacturer of the gaskets that he “used on either the Ford or the Nash Ambassador,” Mr. Yates stated, “Victor gaskets,” and he purchased them from “[t]he Ford place” (Video Deposition 021313, 27:2-8). Regarding “the process of removing the gaskets from the Ford and the Nash Ambassador,” Mr. Yates stated, “You would unbolt the manifold and it would drop away, and then you would have to actually mostly chisel off the gaskets because they had been in there so long. And under that intense heat, they had adhered to the block. So they had to be scraped off…Generally use a chisel, like a wood chisel so they wouldn’t damage the metal” (Video Deposition 021313, 27:12-24). Regarding what was in the air when he “would

chisel off the gasket from the Ford vehicle," Mr. Yates stated, "It was dusty," the dust was visible, and he breathed the dust in (Video Deposition 021313, 27:25-28:7). Regarding what was in the air when he removed the gasket from the Nash Ambassador, Mr. Yates stated, "It was dust in the air," and he breathed the dust in (Video Deposition 021313, 28:11-16). Regarding "[h]ow long it would take to chisel these gaskets off of the Ford vehicle," Mr. Yates stated, "Sometime it would take 15, 20 minutes because it was so intense on there from the heat. It just was not easy to get off" (Video Deposition 021313, 28:17-21). Regarding "the process of putting on the new Victor gaskets," Mr. Yates stated, "Well, you had to clean the surface and then there was a -- call it a gasket seal. It was a high heat sealant that you would put on and then put the gasket on and then put the manifold pipe back on and then tighten them up…Most of the time they came ready cut" (Video Deposition 021313, 28:22-29:7). Regarding whether he recalls "replacing any other gaskets on…[his]…personal vehicles either than the manifold gaskets," Mr. Yates stated, "Replaced the head gasket on the Nash…There again, from what I remember it was a Victor gasket. These were long gaskets about so wide…As long as that six-cylinder engine. You know, they were made to fit…Probably a couple of months after the manifold…Barnes was the only place to but parts except the Ford dealers or the automobile dealers" (Discovery Deposition 021313, 138:14-139:8).

11. Asbestos Exposure from the USS Clearance K. Bronson

Regarding what he means "by decommissioning a ship," Mr. Yates stated, "The ship was taken basically apart and refurbished to make it -- and prepared, preserved, to make it ready in case it needed to be recommissioned so it could be done in the shortest amount of time. Everything was torn out just basically down to the shell and then the mortars and the equipment were readied in case it needed to be recommissioned…Mine [job duty] was in inventory control" (Video Deposition 021313, 34:11-24). Regarding what he did on "an average day in inventory control on the UUS Bronson," Mr. Yates stated, "Well, each morning we were given a list and everything on that list had to be accounted for and checked off and initialed and we would be all over the ship. It may be a water pump in an engine room or it could have been a gun on the upper deck or it could have been something in the galley. But we were on the ship every day, five days a week all over

the place. We would have to go down and -- for instance, in the engine room, it may be a water serial number on there. It was a little tag. And then confirm that that was there and it was correct and check it off" (Video Deposition 021313, 34:25-35:15). Regarding how often he was in the engine room, Mr. Yates stated, "Basically every day at some point -- basically every day…Anywhere from an hour to several hours" (Video Deposition 021313, 35:16-22). Regarding what "other trades and crafts down there preforming work," Mr. Yates stated, "All sorts of maintenance was going on and, again, I said in preparation for the decommissioning…Well, the engineers were doing work on their equipment and the electricians were doing work on their equipment. They were scraping decks. They painted -- scraping and painting equipment. All the equipment had to be chipped and repainted. So it was a multitude of tasks going on down there in a very tight space…Well, walkways below deck are very narrow. You know, you never could pass anybody without touching them, rubbing. You just couldn't get by. And there were grates on the decks. It was so much equipment down there and pipes and steam pipes and air pipes and ventilator pipes and all that stuff that was used when the ship was in commission (Video Deposition 021313, 35:23-36:22).

Mr. Yates stated that he did "have the opportunity to see boiler tenders performing work…[and]…machinist mates" (Video Deposition 021313, 36:25-37:4). Regarding "the types of materials that were on…[his]…inventory list that were down in the engineering spaces," Mr. Yates stated, "Pumps, motors, electric motors, tools. Gosh, any number of things. As I say, water pump, air pumps. The boilers had numbers on them as well but obviously they weren't going anywhere. They were so big. But we still have to inventory them" (Video Deposition 021313, 37:13-22).

Regarding whether they were "handling asbestos insulation on the lines throughout that vessel [the Bronson]," Mr. Yates stated, "Under the engine room, it was steam pipes. It was covered with insulation, and a lot of that stuff was ripped off because it was damaged anyway. So they did handle it. I mean it was handled. It was removed. How much of it, I don't know. Also some of it with the inspections -- pipes had to be inspected if there was any doubt of leakage or whatever" (Discovery Deposition 021313, 58:21-59:6). Mr. Yates agreed that "the Bronson was a steam

driven vessel…turbine” (Discovery Deposition 021313, 60:3-5). Regarding where the steam pipes ran on the ship, Mr. Yates stated, “Bow to stern, but I don’t know the how or if it was done below deck or where. There were lines throughout the ship. Whether they were consecutive, I don’t know. Or whether they ran together, I don’t know” (Discovery Deposition 021313, 60:10-16). Mr. Yates does not “know who manufactured any of the insulation that was on the lines” (Discovery Deposition 021313, 60:17-19). Regarding whether “the removal of and the handling of insulation on the lines on the Bronson [was] dusty,” Mr. Yates stated, “It was dusty some, yeah. I was not in one place. I was moving about the ship, as I said. You would look at this place and then you look at something else and whatever is next on your list” (Discovery Deposition 021313, 61:7-14). Regarding whether there were steam lines everywhere he went while was working, Mr. Yates stated, “No. Because a lot of stuff was on the deck. The pumps and things were on the deck. These would be electric pumps, the ones that I was -- mainly on the deck. There was a big generator or water pump or whatever. I just remember them down and the size and the tag on them that had the number” (Discovery Deposition 021313, 61:15-25). Regarding how his clothes looked at the end of the day, Mr. Yates stated, “I don’t know. I paid no attention to them…They weren’t nasty, if that’s what you mean. They didn’t have black marks and stuff on them because I didn’t do that kind of work…I didn’t brush off. I don’t know…Whatever was in the air. You know, they were tearing stuff down. It had to be something in the air but I don’t know” (Discovery Deposition 021313, 62:4-21).

12. Asbestos from Sanders Motor Company

Regarding what his “typical day was as a parts handler for the Sanders Motor Ford Company,” Mr. Yates stated, “Well, we worked at the parts desk, and the mechanics at the dealership come with their requisition for parts as well as the general public that wanted Ford parts would also come to the counter” (Video Deposition 021313, 39:3-11). Mr. Yates worked “[f]ive and a half” days, “full days Monday through Friday…[and]…half day on Saturday (Video Deposition 021313, 39:12-19). Monday through Friday, Mr. Yates worked “[n]ormally 8 to 5,” and on Saturday, “8 to 1” (Video Deposition 021313, 39:20-24).

Regarding the type of parts he worked with as a parts handler, Mr. Yates stated, “We worked with everything that would build a Ford engine or brakes, mufflers, the engine parts, anything that just about you can imagine. We did a lot of bearings, drums, just general repair parts for the car” (Video Deposition 021313, 40:5-11).

Regarding where the parts supply area was “in relation to where the mechanics performed their work,” Mr. Yates stated, “Well, they were on the same level that we were on plus upstairs, and the mechanics were out on the same level and we were in another area” (Video Deposition 021313, 40:14-19). Regarding the bay areas for the mechanics, Mr. Yates stated, “A bay is just a designated area for each mechanic. It normally had a lift and a place that you could drain oil from the cars there and they worked their little spot. They had their tools and everything and that spot belonged to them. And there was probably 10 or 12 of them there. I honestly can’t give you an exact number but 10 or 12. They were on both sides of the building” (Video Deposition 021313, 40:22-41:7). Regarding “the process when a mechanic would bring…[him]…a requisition form for parts,” Mr. Yates stated, “We would take it and go -- if it was brakes, brake linings, they were upstairs. We would go get them and make sure that we had the right part number for that particular model car. And we always opened the box to make sure that the correct number of shoes was in there. On occasion they would be short, so the box was opened. Sometime we would get maybe several boxes of brakes, three or four boxes of brakes, depending on how many we were going to do, whether they were going to two or four brakes. And then some other things they needed, I would get those and take them back down to the counter. And we would open the box and show him that there were four brakes in there so there was no doubt that there was the right number of brakes so he couldn’t claim a shortage, for instance…They were Ford brakes” (Video Deposition 021313, 41:14-42:11). Regarding what he saw in “these boxes of Ford brakes…besides the brakes,” Mr. Yates stated, “There was always residue in the bottom and sometimes on the brakes themselves, the metal part of the brakes as well…Well, during shipment it looked like where the brake pads had rubbed together and this residue had fallen in the bottom. Sometimes it was a considerable amount and sometimes it was a little in there. But generally every time with brakes there was some dust in there” (Video Deposition 021313, 42:16-43:6). Regarding what would happen when he “opened the Ford brake boxes,” Mr. Yates stated, “Well,

usually in the process of handling it, the dust would rise like normally dust does" (Video Deposition 021313, 43:10-15). Mr. Yates agreed that the dust was visible and that he breathed the dust in (Video Deposition 021313, 43:17-20). Regarding whether he ever had "to actually handle the Ford brakes" out of the boxes, Mr. Yates stated, "Yes. On occasion we would. And reason for that, they were riveted in and sometimes the rivet may be incorrect. And so you would check all the brakes to make sure that they were right or if they were not correct, then you would have to put those in another area to be returned to the manufacturer and get another box and do the same thing…It would get residue on your hands. It would color your hands. It was obviously on there. It was a slick feeling" (Video Deposition 021313, 43:23-44:15). Regarding "how many requisition orders for brakes that…[he]…might have to fill on an average day for the mechanics at the dealership," Mr. Yates stated, "Brakes were a very popular item and we sold a lot of brakes. They did a great deal of brake work…Of course it would vary but…I would say three or four to half a dozen" (Video Deposition 021313, 117:20-118:12). Mr. Yates agreed that he wasn't "the only person filling requisition orders" (Video Deposition 021313, 118:13-15). Mr. Yates agreed that it would "be safe to say that three to twelve brake jobs were being performed in the bays of the dealership" and that "within one box you could have anywhere from two to four brakes" (Video Deposition 021313, 118:25-119:7).

Mr. Yates stated that he would "go into the area where the mechanics were preforming their work…all the time…Sometime it would be to take them apart. If they were extremely busy, we would take the parts back there. Sometimes we just would go back and chitchat with a soft drink. It was in the building. I mean it was just common to go to in there. It was just like a break room" (Video Deposition 021313, 44:17-45:4). Regarding the process of doing brake work "that was being used by the mechanics at the Ford dealership," Mr. Yates stated, "Well, there were various stages of the process, whether it was the same thing as far as taking the wheel or the drum -- I mean the wheels and tires and getting the drum off and get to the brakes. They were a little bit more proficient than I was" (Video Deposition 021313, 45:12-21). Regarding whether the mechanics used a brush, Mr. Yates stated, "A brush was always first. You had to get that cleaned out and then they would use a solvent to make it shiny" (Video Deposition 021313, 46:5-9). Mr. Yates stated that the brush was used "[t]o get the brake dust off" (Video Deposition 021313,

46:10-12). Regarding what was in the air when the mechanics were "using the brush to remove the brake dust," Mr. Yates stated, "It would be in the air, depending on how much was in there. But it could be a whole lot or it could be a little but it was always dust. It had to be dust" (Video Deposition 021313, 46:13-20). Regarding how close he was when he was "around these mechanics performing this type of brake work," Mr. Yates stated, "Again, sometime I would go there and try to learn how they did it, you know, a better way to do it then maybe I was doing it. But you would stand -- I would stand beside of them" (Video Deposition 021313, 46:22-47:3). Mr. Yates believes he breathed the dust in when the mechanics used "the brush to remove the brake residue from the brake shoe" (Video Deposition 021313, 47:20-23). Regarding "[h]ow long would it take for these mechanics to use the brush to remove the residue from the brake," Mr. Yates stated, "Just a couple of minutes" (Video Deposition 021313, 47:24-48:2). Regarding what "happened to the dust from the residue from using the brush," Mr. Yates stated, "It was get (sic) in the air. It was all in front of you…Well, when they did the brush, a lot of it fell on the floor. But it also came up in the air" (Video Deposition 021313, 48:10-19).

Regarding "the process that these mechanics at the Ford dealership would go through in order to put the new Ford brakes onto the car," Mr. Yates stated, "They would sand the lining on the new brakes…Fairly fine grit sandpaper" (Video Deposition 021313, 47:5-13). Regarding what would be in the air "when these mechanics were using the sandpaper on the new Ford brakes," Mr. Yates stated, "There was also dust," and he believes he breathed the dust in (Video Deposition 021313, 47:14-19). Regarding how long he would see "these mechanics sand the brake linings of the Ford brakes," Mr. Yates stated, "Same, just a couple of minutes. It didn't take very long, depending on -- sometime the brakes would be oversized or undersized and they would have to sand more if they weren't fitting it. They would do that instead of turning the drum" (Video Deposition 021313, 48:3-9). Regarding what happened "with respect to the dust from the sanding of the lining," Mr. Yates stated, "Well, the dust from the lining was lighter. It was less of it, obviously. It hadn't accumulated in the bottom of the drum. So most of that just came right up in the air" (Video Deposition 021313, 48:20-49:1). Mr. Yates agreed that this dust was visible (Video Deposition 021313, 49:2-3).

Regarding what “would have to be done to clean up the areas where this brake work had been performed,” Mr. Yates stated, “They swept. On occasion, we swept. But generally it was the mechanics job, but sometimes they would be behind and we would help them…Just an old push broom” (Video Deposition 021313, 49:4-13). Regarding what was in the air when he was sweeping the dust, Mr. Yates stated, “It came out in the air. It was all around us. It was obviously a lot of it after a day’s work,” the dust was visible, and he breathed the dust in (Video Deposition 021313, 49:14-23).

Regarding the process that he used when “individuals would come out from the general public to purchase parts at the dealership,” Mr. Yates stated, “We would open them up when we pulled them from the bin to make -- well, not to be embarrassed and go down there with a box that didn’t have all the parts in it. And then when we get down there, obviously they wanted to check it to make sure that it had the right amount in it so they wouldn’t get back to their job and come up with a part short and have to waste time coming back” (Video Deposition 021313, 49:24-50:12).

Regarding any other “duties that…[he]…had during this six months at this Ford dealership,” Mr. Yates stated, “I felt like it was a promotion where it was. But anyway, I drove a delivery truck. They had salesmen that would go out. Sanders was a large dealer and they serviced these small town dealers in North Carolina, the little one-car showroom dealers they used to call them, that couldn’t afford to buy enough product that could get shipped without having to pay a real heavy delivery charge. So Sanders set up a sales organization and sent people out and then I would follow the salesman with delivering the parts to these small dealers” (Video Deposition 021313, 50:19-51:7). Mr. Yates agreed that during the six months that he worked at Sanders, he drove the delivery truck “anywhere from four to five days per week” (Video Deposition 021313, 51:20-23). Regarding the process of what he “would have to do in order to prepare the truck to go out and distribute all these different Ford parts to the other locations,” Mr. Yates stated, “It was somewhat time consuming but we were required to do it. As we would pull the parts from the salesman’s order, if it was a muffler, it had to be checked before it left the counter and it had to be checked when it went on the truck. If it was brake linings or bearings or whatever, they had to be opened and made sure that the proper number was in there. And they would check before they left the

dealership and they would check when they went on that truck because they could not be short. I certainly wasn't going to take responsibility of having missing parts and have to pay for them myself, so they were checked thoroughly" (Video Deposition 021313, 51:24-52:16). Regarding how many boxes of brakes he would have to check "on a given average day," Mr. Yates stated, "Easy dozen or two and maybe more. Some of these dealers, they didn't buy just what they needed for the jobs that they had scheduled. They were buying what they anticipated would be scheduled because they wouldn't be back for a week. Brakes was a very big item. At that time brakes didn't last very long on automobile" (Video Deposition 021313, 52:17-53:3). Mr. Yates agreed that on average he opened "on average one to two boxes of Ford brakes on these four to five days per week that…[he]…drove the delivery truck…[he's]…looking at about 48 to over 100 boxes of Ford brakes…on average on any given week," and Mr. Yates stated, "Yes. Because they were opened at least three different times…This was probably five months or so that I did that. It could have been seven or eight months that I was there. I just don't recall. But I did the driving most of the time" (Video Deposition 021313, 53:4-23). Mr. Yates agreed that "on overage (sic) anywhere from 48 to 120 Ford brake boxes…four to five days a week over about a five-month period…getting close to anywhere from…1,000 to almost 2,000 brake boxes that…[he]…had to open up" (Video Deposition 021313, 53:24-54:9). Mr. Yates stated that when he opened the brake boxes, he saw "[d]ust" (Video Deposition 021313, 54:11-14). Mr. Yates agreed that the dust was visible, when he opened the boxes, the dust got into the air, and he believes he breathed the dust in (Video Deposition 021313, 54:15-21). Regarding what he had "to do when…[he]…actually got to the place where…[he was]…delivering the brakes to the different dealerships outside of the Raleigh area," Mr. Yates stated, "They would be opened again…Verify the quantity in the box" (Video Deposition 021313, 119:15-120:1).

13. Asbestos Exposure from North Carolina Equipment Depot

Mr. Yates stated that "[t]he North Carolina Equipment Depot is a central location for parts and supplies for the DOT and the divisions that were scattered around DOT and the divisions that were scattered around North Carolina. There 14 divisions from the mountains to the coast. And whatever parts that they needed from tires, mufflers, gaskets, bearings, brakes, they would come

there. They would bring a requisition and come there to get it. They normally would come once a month, sometimes more. So when they came for supplies, they normally got a lot of them because it was going to be several weeks before they got back. So basically the State had cars and trucks that all of them had to have repair parts and they came from us" (Video Deposition 021313, 79:8-80:1). Regarding "the size of this distribution center," Mr. Yates stated, "This is a very large building that's a block and half, two blocks long that they had, as I said, every part you could think of including tires and tires for motor graders and, you know, heavy equipment. So it was a big building" (Video Deposition 021313, 80:23-81:4). Regarding "how were these materials set out throughout the building," Mr. Yates stated, "How they were stored? Obviously the big parts, tires and stuff, were stacked on their own. The bearings, gaskets, the brake shoes, the water pumps, all the generators at that time, all that was stored in bins. The clutch plates, it was all being stored in bins…Well, the division would bring the requisition in that had been approved and then we would take that and start pulling the orders just like at the parts house. Then if they were multiple, like I said, six bearings or 10 gaskets or a dozen brake lining, we would check the numbers again to make sure that they were correct. And then they would be checked again when they were put on the truck so that the driver of the truck could verify that everything was -- the numbers were correct…If it was four brake shoes in a box, then we'd check to make sure it was four. If it was two, it was two. If it was half a dozen bearings, we'd check to make sure it was half a dozen bearings in there. Gaskets, the same thing. Numbers had to -- if they ordered six, it had to be six boxes and it had to be the quantity in that box that was designated on the outside of the box" (Video Deposition 021313, 81:9-82:16). Regarding "how many cars…for which parts were being provided," Mr. Yates stated, "Well, the vehicles I would say were several hundred because you had cars, you had dump trucks and you had pickup trucks. So it was many, many vehicles in the 14 divisions…There were Ford cars -- well, just say there were Ford, Chrysler and GM, and they were all depending on the low bid for that particular year as to what the automobile was or what the truck was" (Video Deposition 021313, 83:9-23).

Mr. Yates stated that "[t]he brakes were Bendix brakes" (Video Deposition 021313, 83:25-84:3). Regarding "how many boxes of Bendix brakes…[he]…would have to open," Mr. Yates stated, "Dozens. Remember that they came here once a month generally and they didn't buy products

that they needed immediately when they got back, I mean they didn't order products. They ordered them that would last them for their 30 days so they wouldn't have to make a trip, say, from Asheville back down here or send somebody to get parts" (Video Deposition 021313, 84:7-16). Regarding "what would happen when…[he]…open these boxes of Bendix brakes," Mr. Yates stated, "You would open them and there was, again, dust residue in that box. And generally they would back up not in the building but to the building. So they were having loaded outside and opened outside, so you could see the dust" (Video Deposition 021313, 84:24-85:5). Regarding what was in the air when he "opened the boxes of Bendix brakes," Mr. Yates stated, "It was dusty," the dust was visible, and he believes he breathed the dust in (Video Deposition 021313, 85:6-13). Mr. Yates stated that the brakes were Bendix drum brakes (Video Deposition 021313, 85:14-19).

Mr. Yates stated that "the gaskets that were being supplied at North Carolina Equipment Depot…were Victor gaskets" (Video Deposition 021313, 85:20-24). Regarding how the gaskets were packaged, Mr. Yates stated, "Normally in -- well, some of them came in little boxes like the gaskets for water pumps that went on for the radiator and the gooseneck, and some of them would be loose in there. They wouldn't be in anything. And some of them would be in paper. Depended on really how fragile the gasket was" (Video Deposition 021313, 85:25-86:7).

Mr. Yates agreed that he did handle clutches, and the clutches were "Borg Warner clutches. It was a big name in clutches at the time" (Video Deposition 021313, 86:12-19). Mr. Yates stated that the Borg Warner clutches came in "[a] box, a single box" (Video Deposition 021313, 86:20-22). Mr. Yates agreed that he would "open the box of a Borg Warner clutch…to verify the proper parts are in the box" (Video Deposition 021313, 86:25-87:4). Regarding often he would "have to open up a box of Borg Warner clutches," Mr. Yates stated, "There again, it varied but generally it would be from two to six. Again, one week you could have two to six or eight and the next week you may not have any. But when we opened them up, they normally came in multiples" (Video Deposition 021313, 87:6-14).

14. Asbestos Exposure from Aircraft Maintenance

Regarding whether he ever got “involved with the maintenance side of the aircrafts,” Mr. Yates stated, “Yes, after I retired and I was doing a lot of flying out of a local airport. And the guy needed a maintenance helper and I thought it would give me an opportunity to learn the maintenance in case I’m out on a cross-country with a student or something and I need a little -- maybe I could fix it on the way back if I needed to. So I helped him do maintenance work…All sorts of from replacing engines to replacing brakes, replacing magnetos, air pumps, instruments. Might be like a directional gyro or a compass or something…Basically Piper, Cessnas and Beechcraft” (Video Deposition 021313, 88:9-89:3).

Regarding the number of brake jobs he assisted on, Mr. Yates stated, “We probably did four a month at least” (Video Deposition 021313, 89:10-16).

Regarding how many engine overhauls he assisted on, Mr. Yates stated, “We didn’t actually overhaul an engine but we replaced the engines. Three of total…Replaced on in a Pipe, one in a Cessna and one in a Beechcraft” (Video Deposition 021313, 89:17-24). Regarding whether he “ever had the opportunity to work with any gaskets,” Mr. Yates stated, “Oh, yes…Well, generally they were manifold gaskets, exhaust gaskets, in general” (Video Deposition 021313, 89:25-90:8). Mr. Yates agreed that he “worked on gaskets on the Beechcraft…the Piper and the Cessna” (Video Deposition 021313, 90:9-15). Regarding what he would “have to do to the gaskets to put them on the engine,” Mr. Yates stated, “Well, once you got them off, again these are air-cooled engines and they operate at about 360 degrees and it was -- they were old engines a lot of them and it was very difficult. The gasket had kind of sealed itself to the manifold and it had to be scraped off” (Video Deposition 021313, 90:16-23). Regarding what he would “have to do to the new gaskets,” Mr. Yates stated, “New gaskets normally were bought to fit. They didn’t have to do any cutting on the manifold gaskets” (Video Deposition 021313, 90:24-91:3).

15. Asbestos-containing Thermal System Insulation (TSI)

"Of the asbestos-containing products which are widely used by these men, magnesia block insulation was and remains perhaps the most important. This usually contains approximately 15 percent asbestos. While asbestos cement has a varying asbestos content depending upon its manufacturer, it also generally has 15-20 percent or less of asbestos…We may conclude that asbestosis and its complications are significant hazards among insulation workers in the United States at this time." (Selikoff, 1965) In the insulating trades, "asbestos content of materials in use ranges from 10% to almost 100%. Asbestos substitutes are gaining in use as regulations over the use of asbestos become increasingly restrictive." (Levin, 1978) "Asbestos, as used by the insulating industry, consists mainly of chrysotile, a magnesium silicate mines principally in Canada, and amosite, an iron magnesium silicate mines in South Africa. Since World War II, amosite has been the most widely used fiber in insulating materials. However…the use of chrysotile has increased to where the two are presently in about the same number of insulating products. Asbestos is usually combined with a filler material such as calcium silicate, in the amounts indicated in Table I, and pre-formed into various shapes, magnesium silicate was often used, but except for some in warehouse stock and a few special orders almost all the new silicate-containing insulating materials are made of calcium silicate."

TABLE I

Type and Per Cent of Asbestos in Insulating Products Used in the San Francisco Bay Area

TYPE OF ASBESTOS	% BY WEIGHT	NO. PRODUCTS
Chrysotile	10-15	2
Chrysotile	85-100	3
Amosite-chrysotile	10-15	3
Amosite	10-15	3
Amosite	95-100	3

(Balzer, Industrial Hygiene 1968)

In another report from Balzer in 1968, "Our analysis of the insulating worker's environment indicates that they are predominately working with calcium silicate and magnesium carbonate

insulating material containing asbestos fibers, fibrous glass materials, plastics, foam glass, cork, and adhesives." Regarding the calcium silicate and magnesium carbonate asbestos-containing insulating material: 100% - Amosite blankets; 95% - Amosite-5% filler; 10-15% - Mixed amosite and chrysotile-85% magnesia; 10-15% - Amosite-85% calcium silicates; 10-15% - Mixed amosite and chrysotile 85% calcined diatomaceous silica; 100% - Chrysotile asbestos shorts for finishing (mud); 50% - Asbestos shorts and 50% cement for finishing (mud). In this same study Balzer reports the percentage and type of asbestos in insulating products in current use:

TABLE IV
Percentage and Type of Asbestos in Insulating Products in Current Use

Type of Asbestos	Percent by Weight	Number of Products
Amosite	10–15%	3
Amosite	95–100	3
Amosite-Chrysotile	10–15	3
Chrysotile	10–15	2
Chrysotile	85–100	3

(Balzer, Environment, 1968)

Fleischer highlights that "AN INDUSTRIAL (sic) health inspection of an important U. S. Navy Contract Yard indicated that dustiness from miscellaneous pipe covering operations was considerable and that a few of the employees had what appeared to be asbestosis." (Fleischer, 1946) Levine further details by stating that "[e]xposures in the insulation trades vary widely, but they include the highest occupational exposures and control is difficult." (Levine, 1978) In a steam-electric generating plant in 1975, Fontaine states "[m]ost of the insulation was preformed pipes and blocks of hydrous calcium silicate insulation reinforced with asbestos fibers." (Fontaine, 1975) Fleischer observed that "[i]n textile plants workers usually continue at specific jobs with fairly constant dust exposures for some years, whereas the pipe coverer may rotate between shop and ship and from small to large ship compartments with a wide variation in dust exposure." (Fleischer, 1946) Harries explains that the "…highest dust concentrations occur during removal of old lagging material. There are other minor processes involving the fitting or removal of asbestos materials some of which produce dust…cleaning with wire brushes, pipes and glands

previously lagged with asbestos. Most of these procedures are carried out intermittingly by men who are not considered to be ‘asbestos workers’.” (Harries, 1968) Browne describes the removal methods for TSI, “[t]he classical method of removing lagging when repairs needed to be done was to go at it with hammer, chisel and wire brush, without damping it, with the consequent production of horrifically high asbestos fiber counts which might persist for as long as a week.” In this same Browne report, “[a]sbestos fiber counts in a power station after the old-style method of removing lagging” produced levels ranging from 2.0 to 492.0 f/cm^3 (n=16), with the highest levels seen around the turbine control panel. (Browne, 1971) According to Harries, “…very large numbers of men have been exposed to asbestos dust by working with or near other men who were applying or removing asbestos materials, or because they themselves were disturbing asbestos debris and creating their own local dust clouds.” (Harries, Asbestos Dust, 1971) In a previous Harries study, “[a]sbestos dust is liberated during manipulation, and especially during vigorous tearing down of most of the asbestos materials used in the dockyard. The main problem is to contain the dust and prevent dispersal throughout the ship.” (Harries, 1968)

In the Harries 1971 study, he reports the level of airborne asbestos in the breathing zone and general atmosphere during pipe and machinery insulation removal and installation. During the removal of pipe and machinery insulation in boiler rooms, engine rooms and brick stowage space, the general atmosphere levels ranged from 0.04 to 3,021.0 f/cm^3 with averages of 171.0, 88.0 and 257 f/cm^3, respectively (n=211). During the removal of pipe and machinery insulation in boiler rooms, engine rooms and brick stowage, the breathing zone levels ranged from 2.0 to 490.0 f/cm^3 with averages of 97.0 and 91.0 f/cm^3, respectively (n=45). During the installation of pipe and machinery insulation in boiler rooms, engine rooms and an accumulator room, the general atmosphere levels ranged from 0.1 to 61.0 f/cm^3 with averages of 22.4, 2.1 and 16.5 f/cm^3, respectively (n=50). During the installation of pipe and machinery insulation in boiler rooms, engine rooms and an accumulator room, breathing zone levels ranged from 0.04 to 68.0 f/cm^3 with averages of 16.8, 7.3 and 9.6 f/cm^3, respectively (n=47). Several miscellaneous activities are associated with pipe and machinery insulation. For “Mixing asbestos ‘plastic mix’ with water in bucket”, general atmosphere levels ranged from 53.0 to 377.4 f/cm^3, with an average of 167.0 f/cm^3 (n=3); breathing zone levels ranged from 24.0 to 579.0 f/cm^3 with an average of 256.0 f/cm^3

(n=12). For “Sawing calcium silicate sections”, general atmosphere levels ranged from 0.7 to 158.0 f/cm^3, with an average of 68.0 f/cm^3 (n=7); breathing zone levels ranged from 7.0 to 152.0 f/cm^3, with an average of 55.0 f/cm^3 (n=11). For “Removing calcium silicates sections from a box”, general atmosphere levels ranged from 2.0 to 78.0 f/cm^3, with an average of 30.0 f/cm^3 (n=7); breathing zone levels ranged from 16.0 to 136.0 f/cm^3 , with an average of 52.0 f/cm^3 (n=10). For “Fitting calcium silicate section to pipe”, general atmosphere levels ranged from 0.0 to 23.0 f/cm^3, with an average of 4.1 f/cm^3 (n=9); breathing zone levels ranged from 1.0 to 129.0 f/cm^3, with an average of 43.0 f/cm^3 (n=20). For “Cleaning calcium silicate debris”, general atmosphere levels ranged from 32.0 to 372.0 f/cm^3, with an average of 134.0 f/cm^3 (n=9); breathing zone levels ranged from 90.0 to 277.0 f/cm^3, with an average of 155.0 f/cm^3 (n=7). For “Fitting cloth over lagged pipe”, breathing zone levels ranged from 0.3 to 43.0 f/cm^3, with an average of 22.0 f/cm^3 (n=7). For “Sweeping and bagging amosite debris” general atmosphere levels ranged from 76.3 to 1,191.0 f/cm^3, with an average of 564 f/cm^3 (n=10). Harries concludes that “precautions are…to protect all workers whether they work directly with asbestos or not [including]...Management Visitors, those who pay short supervisory visits to places where asbestos work is proceeding.” (Harries, Asbestos Dust, 1971)

Levine notes that the “[h]ighest concentrations encountered by insulation workers have occurred during “rip-out” or removal of old asbestos insulations…removal of 100% asbestos lagging, and the subsequent cleanup were said to average…62-159 fibers per milliliter, and 353 fibers per milliliter, respectively….Nearby workers may be exposed to elevated levels of asbestos as a result of the activities of insulators…” (Levine, 1978) Concerning the work environment in a shipyard, Gorman states that “…a lagger recounted how his job frequently put other tradesmen in danger: You used to saw the stuff. Well the, teased-up stuff and the dust just a’ floated. It floated round and everybody got their share.” (Gorman, 2004) Considerable dust measurements were collected by the US Navy while workers were stripping old amosite pipe insulation. So much so that “in view of the high dust counts obtained…that work of this nature be scheduled to lessen [the exposure] to incidental trades when possible.” (US Navy, 1964) In a Balzer study, an average fiber concentration of airborne asbestos in the general vicinity of pipe insulation work was reported to be 8.5 f/cc during prefabrication, 6.4 f/cc during application, 2.7 f/cc during finishing,

8.9 f/cc during tear out, and 2.6 f/cc during mixing. (Balzer, Industrial Hygiene, 1968) In a study conducted by the US Navy during the application of pipe insulation (10% amosite), a dust count of 1.8 mppcf was reported; in an engine room the general atmosphere during the application of insulation was 4.3 mppcf; the general atmosphere near installation of lagging on piping was 7.8 mppcf; sawing insulation blocks for catapult receivers was 6.1 mppcf; installing insulation blocks was 5.0 mppcf; the general atmosphere where blocks are being installed was 3.3 mppcf; the breathing zone of pipe coverers installing insulation block was 6.2 mppcf; and the sawing of insulation blocks produced a dust level of 6.1 mppcf. A sample taken near insulation "ripout" was reported to be 17.0 mppcf; removing steam pipe insulation was 20.0 mppcf; and after "ripout" had occurred was 12.0 mppcf. Because of the dust samples reported, the Navy states that "[t]hese samples indicate the possibility of excessive exposure to asbestos dust." (US Navy, 1961) According to a NIOSH study, "[c]utting calcium silicate, block, pipe #1" in a powerhouse open space using a table and hand saw was reported to be 1.2 fibers/ml; "[c]utting calcium silicate, block & pipe #2" in an industrial building in good ventilation was reported to be 4.1 fibers/ml; "[c]utting of calcium silicate block & pipe" in an apartment house boiler room with no ventilation was reported to be 11.5 fibers/ml in the breathing zone; "[c]utting of calcium silicate block & pipe #4" with limited ventilation was reported to be 9.4 fibers/ml, with an area sample reported to be 1.6 fibers/ml (3.0-4.0 feet away). (NIOSH, 1972)

A 1992 study by Ewing investigated exposure to airborne asbestos during disturbance of thermal system insulation on a boiler. A section of boiler insulation, approximately 1.5 square feet, was removed. Two personal air samples were analyzed by transmission electron microscopy (TEM), with results of 305.0 asbestos structures per cubic centimeter (s/cc) and 147.0 s/cc. Area samples, also analyzed by TEM, ranged from 2.5 to 115 s/cc (n=6). After the removal period was completed, or during the "die-down" period, area samples ranged from 6.1 to 12.0 s/cc (n=5). General cleaning activities were also investigated, and the cleaning portion of the study was conducted prior to the maintenance activity. Area samples were analyzed by TEM, and results ranged from 6.5 to 106.0 s/cc (n=6). A personal air sample analyzed during this activity resulted in an asbestos level of 76.0 s/cc. (Ewing, Boiler, 1992)

In a 1970 study by the US Navy, "[a]irborne asbestos dust samples were collected aboard several ships of various sizes, ranging from destroyers to aircraft carriers, and in the shop complex." Samples were analyzed and reported in mppcf. "Asbestos cloth; cutting, fitting, glueing (sic), and installing" resulted in a range from 2.8 to 5.7 mppcf, with an average of 4.3 mppcf. "Magnesia block; cutting, installing" resulted in a range from 3.5 to 40.5 mppcf, with an average of 16.7 mppcf. "Magnesia block…(cutting, glueing(sic))" resulted in a range from 1.1 to 1.3 mppcf, with an average of 1.2 mppcf. "Amosite…(cutting, fitting, applying)" resulted in a range from 0.4 to 4.7 mppcf, with an average of 2.4 mppcf. "Asbestos cloth…(cutting, fitting, sewing)" resulted in a range from 0.1 to 4.0 mppcf, with an average of 0.2 mppcf. "Amosite: Installation" resulted in a range from 2.6 to 8.9 mppcf, with an average of 5.6 mppcf. "Magnesia block: Cutting & installing" resulted in a range from 2.4 to 13.3 mppcf, with an average of 6.1 mppcf. "Asbestos cloth: cutting, fitting, glueing (sic)" resulted in a range from 3.1 to 4.6 mppcf, with an average of 3.6 mppcf. "Asbestos cement: Mixing" resulted in a range from 11.5 to 82.8 mppcf, with an average of 47.5 mppcf. The study concludes, "[i]n general, workers handling, sawing, cutting or ripping-out asbestos materials produce considerable amounts of very fine asbestos fibers and particles in their breathing zone." (Mangold, 1970)

In the work environment, asbestos-related risk and disease associated with the manipulation of thermal system insulation above background levels can be seen in the literature. (Finkelstein, 2004) (Selikoff, 1965) (Fletcher, 1971) (ASTDR, Asbestos and Your Health, 2006) (OSHA FR, 1994) (Dodson, 2006) (Balzer, 1972) (Cooper, 1970) (Army, 1992) (Marr, 1964) (Merewether, 1930) (Cross, 1971) (Balzer, Environment, 1968) (Divine, 1999) (Lewis, 2000) (Jones, 1981)

16. Asbestos-containing Gaskets

"The term 'gasket' is a general term for a number of sealing materials, including sheet gaskets and packing. Sheet gasket materials are used to seal pipe joint connections and prevent leakage of fluids between the solid surfaces of the pipe flanges…Gaskets, often consisting of more than 70% chrysotile asbestos, are used against alkaline, neutral or weak acid solutions. Crocidolite (blue asbestos) containing gaskets have been used against harsher acid solution. Sheet gaskets are

composed of chrysotile asbestos compressed into a sheet with styrene butadiene rubber or other binder. Other organic binder used in making asbestos gaskets include natural rubber, buna-S and buna-N synthetic rubbers, or neoprene. Sheet gasket material is sold in a farm that is precut to fit a certain size flange or may be sold in sheets from which gaskets are cut to fit a particular flange assembly. In their original state, gaskets which are composed of asbestos in an organic binder are not considered friable. However, gasket material after service may be friable." (Millette, Mount, Hays, 1996) "…gaskets normally contained 70 percent to 80 percent chrysotile asbestos by weight. In some cases crocidolite asbestos was used for special applications, that is, sealing flanges in acid lines. The remaining non-asbestos component of the gasket was usually constructed of synthetic rubber material that consisted of either neoprene, styrene butadiene rubber (SBR), or a nitrile polymer." (Longo, 2002) In a 1992 asbestos exposure study, the gasket material was found to have an asbestos content of 50-60% chrysotile asbestos. (McKinnery, 1992) In a Mangold study, he reports that a typical gasket used in the 1940's to the 1970's were "about 70% chrysotile asbestos." (Mangold, 2006) Cheng reports typical gasket material in the oil and chemical industries to be "Sheet gaskets, which are typically 1/16 or 1/8 inch thick compressed asbestos sheets (containing at least 70% chrysotile asbestos)…Spiral wound gaskets, which consist of asbestos filler material…Metal-jacketed gaskets, which consist of compresses asbestos filler…" (Cheng, 1991) "Asbestos is the primary constituent for making compressed sheet gaskets (varying upwards from 75 percent by weight depending on the application)." (ICF, 1989)

Studies addressing airborne asbestos exposures produced by removal of sheet gaskets have been published by Millette, Mount, and Hays. Sheet gaskets are composed of asbestos compressed with binders, such as natural or synthetic rubbers. "In their original state, asbestos-containing sheet gasket materials which are composed of asbestos in an organic binder are not considered friable. However, gasket material after service may be dry and friable." Millette, Mount, and Hays reported asbestos concentrations when removing sheet gaskets ("Garlock" brand) by various combinations of hand scrapping and power wire brushing. Samples were collected in this study: 1) before and during the removal of asbestos sheet gasket material and wire-brushing of the pipe flange, and 2) during the cleanup of asbestos dust and debris following a cutting of a gasket

material with a band saw. These results were from analyses of the samples by phase contrast microscopy (PCM), NIOSH method 7400. Some of the samples were also analyzed by TEM using the International Standards Organization (ISO) direct preparation method. The sheet gaskets in the study were removed from a steam valve that had been in service on a ship. During sampling event 1, PCM analysis reported asbestos levels during "hand scraping", "power wire brushing", "hand scraping and power wire brushing", and "broom sweeping of area after removal" at 0.14, 6.8, 2.1, and 5.5 f/cc, respectively. For TEM analysis, these same tasks reported levels at 3.9, 62.0, 20.0 and 44.0 s/cc, respectively. During sampling event 2, PCM analysis reported asbestos levels during "cutting of the gasket", "background before sweeping", and "sweeping of dust and debris" at 11.0, 0.13, and 1.7 f/cc, respectively. For TEM analysis, these same tasks reported levels at 30.0, 0.37, and 5.9 s/cc, respectively. (Millette, 1995)

Longo, Egeland, Hatfield, and Newton reported airborne concentrations during removal of sheet gaskets from a variety of small and large valve and flange assemblies. These had been in service at a power house. The gasket material used in this study contained 65% to 85% asbestos. Removal was done using combinations of hand scraping, hand wire brushing, and power wire brushing. All removal was done dry. All airborne concentrations were reported in fibers per cubic centimeter, and only fibers greater than 5 micrometers in length were included in the reported concentrations. **For small flange removal**, using a scraping and hand wire brush method, personal "worker" samples analyzed by PCM ranged from 1.5 to 10.1 f/cc (n=14), with a calculated 8-hr TWA of 1.5 f/cc, and personal "worker" samples analyzed by TEM ranged from 29.9 to 144.2 f/cc (n=14). Personal "assistant" samples analyzed by PCM ranged from 1.2 to 4.2 f/cc (n=14), with a calculated 8-hr TWA of 1.0 f/cc, and personal "assistant" samples analyzed by TEM ranged from 2.2 to 29.5 f/cc. **For large flange removal**, using a scraping and hand wire brush method, personal "worker" samples analyzed by PCM ranged from 9.3 to 24.0 f/cc (n=10), with a calculated 8-hr TWA of 3.6 f/cc, and personal "worker" samples analyzed by TEM ranged from 199.6 to 842.7 f/cc (n=14). Personal "assistant" samples analyzed by PCM ranged from 5.2 to 15.7 f/cc (n=10), with a calculated 8-hr TWA of 2.0 f/cc, and personal "assistant" samples analyzed by TEM ranged from 13.6 to 101.0 f/cc. "Area" asbestos levels for this activity were reported by PCM at a range of 2.1 to 8.4 f/cc (n=24), and by TEM at a range of 3.3 to 108.8 f/cc

(n=24). **For large flange removal**, using a power wire brush method personal, “worker” samples analyzed by PCM ranged from 14.9 to 31.0 f/cc (n=7), with a calculated 8-hr TWA of 2.3 f/cc, and personal “worker” samples analyzed by TEM ranged from 877.1 to 1,636.1 f/cc (n=7). Personal “assistant” samples analyzed by PCM ranged from 12.8 to 21.2 f/cc (n=8), with a calculated 8-hr TWA of 2.0 f/cc, and personal “assistant” samples analyzed by TEM ranged from 60.4 to 364.4 f/cc (n=8). “Area” asbestos levels for this activity were reported by PCM at a range of 7.6 to 15.7 f/cc (n=16), and by TEM at a range of 56.9 to 801.9 f/cc (n=16). {emphasis added}(Longo et al., 2002)

McKinnery and Moore reported airborne concentrations for the removal and installation of asbestos-containing valve gaskets. Work practices and tools used conformed to those used by maintenance personnel. Both personal and area samples were collected. During the **removal** of the gaskets, personal samples analyzed by PCM ranged from 0.05 to 0.44 f/cc (n=23), with a geometric mean of 0.16 f/cc, and personal samples analyzed by TEM ranged from 0.86 to 18.45 s/cc (n=26), with a geometric mean of 2.73 s/cc. During the removal of the gaskets, area samples collected at various points within containment and analyzed by PCM ranged from 0.00 to 0.59 f/cc (n=49), while area samples analyzed by TEM ranged from 0.29 to 28.22 s/cc (n=42). During the **installation** of the gaskets, personal samples analyzed by PCM ranged from 0.13 to 0.29 f/cc (n=12), with a geometric mean of 1.28 f/cc, and personal samples analyzed by TEM ranged from 0.4 to 74.32 s/cc (n=12) with a geometric mean of 3.40 s/cc. During the installation of the gaskets, area samples collected at various points within containment and analyzed by PCM ranged from 0.11 f/cc to 0.35 f/cc (n=24), while area samples analyzed by TEM ranged from 0.85 s/cc to 5.53 s/cc (n=24). (McKinnery et al., 1992)

In a Boelter study, in-place gaskets were manipulated with various actions on machinery in relation to the industrial and maritime industries. Industrial “flat blade scraping” resulted in personal asbestos levels of 0.028 and 0.035 f/cc; “room air” asbestos levels were reported to range from 0.020 to 0.034 f/cc (n=8). Industrial “hand wire brushing” resulted in personal asbestos levels of 0.005 and 0.007 f/cc; “room air” asbestos levels were reported to range from 0.005 to 0.010 f/cc (n=8). Industrial “power wire brushing” resulted in personal asbestos levels of 0.021

and 0.023 f/cc; “room air” asbestos levels were reported to range from 0.015 to 0.020 f/cc (n=8). Industrial “making gaskets with a ball peen hammer” resulted in personal asbestos levels of 0.038 and 0.052 f/cc; “room air” asbestos levels were reported to range from 0.030 to 0.048 f/cc (n=8). Maritime “flat blade scraping” resulted in personal asbestos levels of 0.014 and 0.019 f/cc; “room air” asbestos levels were reported to range from 0.014 to 0.020 f/cc (n=8). Maritime “hand wire brushing” resulted in personal asbestos levels of 0.0 and 0.004 f/cc; “room air” asbestos levels were reported to range from 0.001 to 0.004 f/cc (n=8). Maritime “power wire brushing” resulted in personal asbestos levels of 0.008 and 0.010 f/cc; “room air” asbestos levels were reported to range from 0.008 to 0.014 f/cc (n=8). Maritime “making gaskets with a ball-peen hammer” resulted in personal asbestos levels of 0.022 and 0.029 f/cc; “room air” asbestos levels were reported to range from 0.017 to 0.025 f/cc (n=8). (Boelter, 2002)

According to Cheng, dry scraping/brushing two gaskets during a valve replacement resulted in an airborne asbestos concentration of 0.11 fibers/cc; dry scraping/brushing one gasket for a pump resulted in an airborne asbestos concentration of 0.19 fibers/cc; dry scraping/brushing two flange gasket resulted in an airborne asbestos concentration of 0.33 fibers/cc; dry power sanding two pipe flange gaskets resulted in an airborne asbestos concentration of 1.4 fibers/cc; wet scraping/brushing one gasket for a pump resulted in an airborne asbestos concentration of <0.06 fibers/cc; and wet brushing two pipe flange gaskets resulted in an airborne asbestos concentration of <0.06 fibers/cc. (Cheng, 1991)

The literature is replete with worker and/or bystander asbestos exposure above background levels through the removal, installation and cleanup of asbestos-containing gaskets. (Anderson, 1982) (Liukonen, 1978) (Silverhorne, 1973) (Hatfield, 2001) (Hatfield & Bennett, 1985) (Hatfield, Spiral Wound, 2000) (Jones, 1981) (Spence, 1998) (Longo, 2006) (Boelter, 2002) (Mangold, 2006) (Millette, Mount, Hays) (Fowler, 2000) (Longo, 2001) (Mount, 1988) (Boelter, 2011) (Madl, 2007)

17. Asbestos-containing Friction Products

“Asbestos has-been used in brake linings and other friction products since the turn of the century, when metals, leather, and wood no longer were adequate…The predominant type of asbestos used in brake linings is chrysotile, a hydrated magnesium silicate…Passenger car and light truck drum brake linings, called segments, usually contain from 30 to 70 percent by weight of asbestos.” (ASME, 1987) “The composition of automotive brake linings includes chrysotile asbestos fibre which comprises about 50% of the friction material.” (Rohl, 1977) “Brake linings pose a potential hazard for asbestos exposure because they contain 33-73% asbestos.” (Lorimer, 1976) “Commercial friction materials used in the United States for braking passenger cars and trucks contain an average composition of 50 percent chrysotile by weight.” (Castleman, 1975) “Brake lining materials contain 40-60 per cent of asbestos.” (Hickish, 1970) For disc brake pads for light/medium vehicles, “Currently, asbestos only comprises 15 percent of the OEM for disc brake pads; the balance of 85% is held by semi-metallics.” (ICF, 1989) {OEM=original equipment market} “Clutch facings are friction materials attached to both sides of the steel disc in the clutch mechanism of manual-transmission vehicles. Two metal pressure plates flanking the disc are pressed against the clutch facings by springs when the clutch is engaged. This pressure keeps the gears of the vehicle in position by means of a metal component that extends between the disc and the gears…Asbestos–based molded clutch facings currently produced contain approximately 0.26 lbs. of asbestos fiber per piece.” (ICF, 1989)

According to a 1986 EPA document, “Millions of asbestos fibers can be released during brake pad and clutch servicing…Asbestos released into the air lingers around a garage long after a brake job is done and can be breathed in by everyone inside a garage, including customers.”(EPA, 1986) Concerns about exposure to asbestos-containing dust from automotive maintenance and repair work can be found in the other literature. (Sheehy, 1987) (Huncharek, 1989) According to a 1987 study discussing the feasibility of asbestos in automobiles and trucks, authored by the American Society of Mechanical Engineers for the EPA, “[s]uitable non-asbestos materials are not available for all of these applications, and industry-wide substitution of non-asbestos materials in all existing brake designs would require considerable development. It is unrealistic to

assume that all automakers will redesign all passenger car and truck braking systems around disc brakes in order to utilize semimetallic materials… Adequate non-asbestos friction material formulations presently are not available for all vehicle systems. However, at the present rate of technical progress, most new passenger cars could be equipped with totally non-asbestos frictional systems by 1991, and most light trucks and heavy trucks with S-cam brakes, by 1992." (ASME, 1987)

In a review by Lemen, it was reported that "chrysotile asbestos was found in all dust samples taken from car brake drums, with 2-15% in each sample in both fiber and fibril forms, with average concentrations from blowing the dust of 16 fibers/ml of air…" with measurable concentrations found 75 feet away. In Lemen's review, it is noted that "fiber concentrations of 3.8 fibers/ml among New York brake repair workers" were found. Furthermore, "[g]rinding of the linings produced the most asbestos fiber release, some as high as 125 fibers/cm^3…" Lemen concludes, "[a] review of the published peer reviewed literature reveals at least 165 cases of mesothelioma in end-product users [mechanics] of friction products…and that the results of the exposure studies, experimental studies, case reports, and findings from the equivocal epidemiological studies by no means exonerate the brake mechanic from being susceptible to a causal relationship between asbestos exposure and mesothelioma." (Lemen, 2004)

In a Millette study dealing with asbestos-containing brake shoes and brake disc pads manufactured by Ford, during the sanding of brake shoes, asbestos fiber levels were 2.2 fibers/cc (PCM), 54.0 structures per cubic centimeter (s/cc) (> 5μm, TEM); during the sweeping of dust and debris; asbestos fiber levels were 1.7 fibers/cc (PCM), 12.0 s/cc (> 5μm, TEM); during filing of grooves, asbestos fiber levels were 0.3 fibers/cc (PCM), 6.7 s/cc (> 5μm, TEM); during the making of grooves in the disc pad for two minutes with a power grinder, asbestos fiber levels were 8.5 fibers/cc (PCM), 231.0 s/cc (> 5μm, TEM). Millette further concludes that "[s]anding an asbestos-containing brake shoe friction product with a coarse sandpaper released high levels of asbestos fibers in the breathing zone of the sander. Sweeping the asbestos-containing dust and debris following sanding can release significant levels of asbestos fibers into the air (over 1 f/cc). Filing grooves into a brake disc pad also releases asbestos fibers into the air in the vicinity of the

filer, but at a lower level than sanding. Using a power muffler grinder to cut the grooves in an asbestos-containing brake disc pad causes high levels of asbestos to be released." (Millette, 1996) Rohl states, "[t]he composition of automotive brake linings includes chrysotile asbestos fibre which comprises about 50% of the friction material." In this paper, exposure ranges and means, reported in f/ml (PCM), from friction products during automotive brake repair include blowing dust from brake drums at a distance from 1 – 1.5 meters (m), in which the range was 6.6 to 24.9 f/ml with an average of 15.0 f/ml (n=4); at a distance from 1.5 – 3 m, in which the range was 2.0 to 4.2 f/ml, with an average of 3.3 f/ml (n=3); and at a distance from 3 – 6 m, in which the range was 0.3 to 4.8 f/ml with an average of 1.6 f/ml (n=2). Background samples collected 5 minutes after air jet blowing at a distance of 3.6 – 16 m, revealed a range from 0.1 f/ml to 0.2 f/ml with an average of 0.2 f/ml (n=2). Background samples collected 7-14 minutes after "air jet blowing" at a distance of 19.6 – 22.6 m, revealed an average of 0.1 f/ml (n=2). During truck brake repair, "renewing used linings by grinding" at a distance of 1 – 1.5 m, revealed a range of 1.7 to 7.0 f/ml with an average of 4.8 f/ml (n=10). Background samples taken during grinding used linings at a distance of 3.3 m, the range was 1.2 to 1.7 f/ml with an average of 1.5 f/ml (n=2); at a distance of 8.3 m, the range was 0.6 to 1.0 f/ml with an average of 0.8 f/ml (n=2); and at a distance of 20 m, the level was 0.2 f/ml. Samples collected during bevelling new linings revealed a range from 23.7 to 72.0 f/ml, with an average of 37.3 f/ml (n=4). At a distance 2.4 m away from bevelling new linings, a level of 0.6 f/ml is reported; at a distance of 3.4 m away, a range from 0.3 – 0.5 f/ml and an average of 0.4 (n=2) is reported; and at a distance of 9.1 m away, a level of 0.3 f/ml is reported. (Rohl, 1977)

In a review to the EPA titled "Asbestos Dust Control in Brake Maintenance", exposure levels, reported in f/cc (PCM), from working with asbestos-containing brake products are reported. The use of a compressed air gun for several studies resulted in a range of 0.14 to 2.69 f/cc with a TWA of 0.03 f/cc and an average peak level of 0.71 f/cc; a range of 0.91 to 15.0 f/cc with a TWA of 0.13 f/cc and an average peak level of 4.87 f/cc; a range of 6.6 to 29.8 f/cc with an average peak level of 16.00 f/cc; a level of 0.85 f/cc; a level of 0.33 f/cc with a TWA of 0.4 f/cc; and a range of 0.6 to 3.00 f/cc with an average peak level of 1.43 f/cc. The use of a dry brush or rag for two studies resulted in a range of 0.61 to 0.81 f/cc with a TWA of 0.19 f/cc and an average peak

level of 0.70 f/cc; and a range of 1.3 to 3.6 f/cc with an average peak level of 2.5 f/cc. The use of a damp brush or rag resulted in a range of 0.67 to 2.62 f/cc with a TWA of 0.25 f/cc and an average peak level of 1.4 f/cc. The use of brake cleaner/compressed air resulted in a range of 0.25 to 0.68 f/cc with a TWA of 0.07 f/cc and an average peak level of 0.41 f/cc. (PEI Associates, 1985)

In another study, compressed air blown onto a wheel and brake assembly reported area levels at 3.17 and 2.48 f/cc (PCM), 5.39 and 11.75 (FIBERS> 5µm/cc, TEM), respectively. Personal samples ranged from 4.13 to 16.52 f/cc (PCM) (n=4) and <8.32 to 33.71 (FIBERS> 5µm/cc, TEM) (n=4), respectively. (Longo, 1998) In another similar report produced by Hatfield and Longo, they "conducted a study to determine exposures to airborne asbestos fibers generated while performing compressed air blowout on a brake assembly that contained non asbestos brake shoes, but contained residual asbestos contaminated brake dust from the previous shoe friction material." During the "1st Wheel Blowout" area samples ranged from 0.04 to 0.09 f/cc (PCM) (n=4), 1.32 to 3.98 (FIBERS> 5µm/cc, TEM) (n=4); while personal samples ranged from 0.52 to 1.03 f/cc (PCM) (n=4), 6.71 to 6.77 (FIBERS> 5µm/cc, TEM) (n=4). During the "2nd Wheel Blowout," area samples ranged from 0.07 to 0.11 f/cc with one sample overloaded (PCM) (n=4) and "None Detect" to 7.83 f/cc (FIBERS> 5µm/cc, TEM) (n=4); personal samples ranged from 0.56 to 1.72 f/cc (PCM) (n=4) and 6.77 to 40.63 (FIBERS> 5µm/cc, TEM) (n=4). Thirty minutes after compressed air use, area samples ranged from 0.01 to 0.03 f/cc with one sample overloaded (PCM) (n=4) and 0.19 to 0.96 (FIBERS> 5µm/cc, TEM) (n=4). They concluded that "[d]uring this process, significant amounts of asbestos fibers are released into the air." (Hatfield, 2001)

According to Hickish, atmosphere samples during car brake service by a car were 1.12 and 1.42 fibers/cm^3; atmosphere samples during car brake service in a "dust cloud then by car" were 1.71 and 3.62 fibers/cm^3; personal samples during brake services ranged from 0.21 to 1.12 (n=6); personal samples during truck brake service during and after cleaning was 7.09 and 0.08 fibers/cm^3, respectively; and during clutch repair procedures during cleaning and after cleaning, personal asbestos airborne levels were 2.25 and 0.11 fibers/cm^3, respectively. (Hickish, 1970) In a study by Lorimer, garage brake lining maintenance work for trucks, including the renewal of used

linings by grinding resulted in asbestos airborne concentrations ranging from 1.7 to 5.6 fibers/cc (n=10). (Lorimer, 1975)

The US EPA states that "[w]hen grinding is done to renew used brake block linings, concentrations of up to seven million asbestos fibers per cubic meter can be released. Beveling new linings can release concentrations of up to 72 million fibers and light grinding of new linings of up to 4.8 million fibers." With regard to clutch repair, "[s]ignificant exposure can also occur during clutch repair. Since a mechanic's head is typically under the clutch assembly during clutch repair, asbestos often falls on a mechanic's face and clothing." (EPA, Brake Mechanics, 1986)

It has been documented that there were complaints and health concerns regarding asbestos dust being identified in brake lining boxes and packages at least between 1973 through 1983 (1973 RW to Abex) (1975 RW to Abex) (1977 RW to Abex) (1983 RW to Abex) (1983 RW to Abex).

The literature is replete with asbestos exposure above background levels in the brake repair and maintenance industry. (Dodson, 2006) (Moore, 1988) (Weir, 2001) (Hickish, 1968) (Johnson, 1976) (Johnson/Zumwalde, 1979) (Cheng, 1986) (Paustenbach, 2003) (Boelter, 2007) (Rohl, 1977) (NIOSH, 1972) (Abex, 1972) (Ammco, Jan. 1973) (Ammco, June 1973) (Ammco, 1978) (Ammco, 1986) (Ammco, 1988) (Castlemen, 1975) (Sakai, 2006) (Lemen, 2004)

18. Conclusions

Based on the information detailed above, we have been asked to evaluate Mr. Yates' exposures to asbestos-containing thermal systems insulation, gaskets, and friction products, or any resultant asbestos-containing dust. As to those exposures, we provide the following opinions.

A. Mr. Yates' work history is summarized in Section 8 of this report. As detailed in Sections 9 through 14, during his career he worked with and around these types of products. Based on the facts, data, and assumptions, these products were asbestos-containing or asbestos insulated during the period of Mr. Yates' work.

B. Significant exposure to asbestos includes the installation, removal, cutting, manipulation, handling, repairing, or in any way disturbing of an asbestos-containing product, or any resultant asbestos-containing dust, in such a manner that airborne asbestos fiber concentration is released above background concentration. ATSDR reports asbestos background as a range between 10^{-8} to 10^{-4} PCM f/ml.

C. When the asbestos products, or any resultant asbestos-containing dust, were installed, removed, cut, manipulated, repaired, handled, or in any way disturbed, Mr. Yates, while working with such products or as a bystander, was exposed to significant airborne concentrations of asbestos for each type of product.

D. Airborne asbestos does not settle quickly from the air and can easily become re-entrained after it does settle.

E. Since the 1930's, working with or around hazardous contaminants in the work place, the need for appropriate training, appropriate respiratory protection, and adequate engineering controls were recommended. Asbestos was included among these workplace hazards. Good industrial hygiene practices would have included warnings.

F. We found no evidence of the use of appropriate training, appropriate respiratory protection, or adequate engineering controls. Appropriate training, appropriate respiratory protective equipment, and adequate engineering controls will reduce the exposure to airborne asbestos.

G. The dangers of exposure to asbestos-containing products have been well documented in the scientific literature. By 1938, asbestosis had been thoroughly documented, and by 1955, the link between asbestos and lung cancer had been firmly established in public health and industrial safety literature.

I declare under penalty of perjury that the foregoing is true and correct.

Steve M. Hays, PE, CIH
Chairman, Gobbell Hays Partners, Inc.

APPENDIX A

Literature References

1. Introduction

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APPENDIX B

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EDUCATION:

Bachelor of Engineering/Chemical Engineering/1973
Vanderbilt University; Nashville, Tennessee

CERTIFICATIONS/REGISTRATIONS:

1978/Professional Engineer/Tennessee
1982/Professional Engineer/Alabama
1983/Professional Engineer/New Mexico
1989/Professional Engineer/Arkansas
1989/Professional Engineer/Florida
1989/Professional Engineer/Illinois
1990/Certified Industrial Hygienist/American Board of Industrial Hygiene
1990/Chartered Membership/The Institution of Engineers of Ireland
1991/Professional Engineer/Virginia
1991/Professional Engineer/California
2000/Professional Engineer/Ohio
1996/Qualified Environmental Professional/The Institute of Professional Environmental Practice

PROFESSIONAL SUMMARY:

Mr. Hays, GHP partner and chairman of the board, is the driving force behind the firm's development as a recognized leader in dealing with hazards in the built environment. His background in the chemical industry, his certification as an industrial hygienist and his knowledge of building systems give him a unique expertise in providing consulting services related to environmental hazards. His involvement since 1981 in environmental management

and/or abatement design at over 10,000 facilities has helped give Gobbell Hays Partners, Inc. (GHP) a national client base, with projects in geographic locations from San Juan, Puerto Rico, to Anchorage, Alaska.

Mr. Hays serves as a seminar faculty member at Georgia Tech Research Institute and The Environmental Institute. He is a former guest lecturer at the University of California at Berkeley and Texas A & M University. Mr. Hays has lectured on the following environmental-related topics:

Asbestos

Abatement Site Safety Update
Asbestos Abatement in Occupied Facilities
Asbestos Abatement Oversight and Management
Asbestos Abatement in Industrial Settings
Bulk Sampling and Documentation Procedures
Cost Estimating
Designing the Abatement Project: Design Laboratory
Design: Project Specifications
Design Update: Abatement Specifications
Design Update: AHERA and Beyond
Design Update: Special Design Considerations
Design Update: Mini-Laboratory Workshop
Development and Implementation of Contract Specifications
Elements of Technical Specifications for Asbestos Abatement Projects
Glovebag Techniques as an Abatement Response Action
HVAC System Modification During Abatement Projects
Inspection and Assessment Techniques
Lockdown/Replacement Techniques and Asbestos Substitutes
Pre-Inspection Planning
Pre-Work Activities and Considerations
Presentation of the NIBS Operations and Maintenance (O&M) Work Practices Manual
Project Design Considerations
Relevance of Settled Dust to the Design of Operations and Maintenance Programs and Abatement Projects
Understanding Building Systems

Environmental Audits/Assessments

Case Studies in Environmental Site Assessments
Chemistry and Environmental Laboratory Review

Pesticides, Insecticides, Herbicides and Fertilizers
Polychlorinated Biphenyls (PCBs)
Roles and Responsibilities of Consultants and Owners
Underground Storage Tanks: Regulations, Assessments and Corrective Measures

Lead-Based Paint

Abatement Design Strategies: Design Laboratory
Control Options
Contract Specifications and Critique
Project Management

Mold

Mold Assessment and Remediation in Buildings

Other Lectures

Design of a Transmission Electron Microscopy (TEM) Laboratory

Has lectured at University of Kentucky, Texas A & M, and New York University on asbestos-related topics.

COMMITTEES/COMMISSIONS:

Environmental Protection Agency (EPA)

Member, Policy Dialogue Committee to advise EPA on future regulation concerning asbestos-containing material in public and commercial buildings.

Peer reviewer for several EPA documents, including Managing Asbestos In Place ("Green Book").

Member, 24-person committee seated by EPA to negotiate the regulatory language as required under the Asbestos Hazard Emergency Response Act (AHERA), effective December, 1987.

The Environmental Information Association

Past President, The Environmental Information Association.

Past Secretary, National Asbestos Council.

Past Member of the Board, National Asbestos Council.

Past Chair, Awards and Sponsorship Committee for National Asbestos Council.

Past Chair, Professional Registration Committee for National Asbestos Council.

Past Co-Chair, ad-hoc membership group to study professional practice guidelines for the National Asbestos Council.

Past Chair, ad-hoc committee to establish liaison memberships with other professional associations for the National Asbestos Council.

National Institute of Building Sciences (NIBS)

Past Chair, Board of Directors for NIBS
Past Member, Indoor Air Quality Task Force for NIBS

Past Member, Project Committee for NIBS for preparation of lead-based paint abatement guidelines

Past Member, Task Force Steering Committee for preparation of asbestos abatement guideline specifications

Past Member, Radon Standards Project Committee

Past Chair, Asbestos Project Committee

Past Member, Consultative Council

Past Member, 1993 Consultative Council Planning Committee

Past Member, Environmental Integration Committee

Past Member, NIST Steering Committee

Additional Positions

Member, Advisory Committee on Childhood Lead Poisoning Prevention, Centers for Disease Control and Prevention (CDC)

Member, Indoor Environmental Quality Committee for the American Industrial Hygiene Association (active member from June 1994 – December 2001)

Chair, Lead Subcommittee of the Indoor Environmental Quality Committee for the American Industrial Hygiene Association

Member, Editorial Advisory Board for *American Consulting Engineer*, a publication of the American Consulting Engineers Council

Member, Editorial Advisory Board for *Lead Detection & Abatement Contractor*

Member, Editorial Advisory Board for *Indoor Environment Connections*

Facilitator and Expert, Peer Review Panel for HUD's Healthy Homes Initiative

Past Chair, Committee of Visitors for the School of Engineering, Vanderbilt University

Peer Reviewer, "HUD Guidelines for Evaluation and Control of Lead-Based Hazards in Housing"

Member, Committee on Sampling and Analysis of Atmospheres for the American Society for Testing and Materials (ASTM)
Member, Committee on Performance of Buildings for the American Society for Testing and Materials (ASTM)

Past Chair, Public Relations Committee for the American Consulting Engineers Council (ACEC)

Past Member, Environmental and Public Health Council, Underwriters Laboratories Inc.

Past Member, Committee seated by the Society for Occupational and Environmental Health for the development of the document "Protecting Workers and Their Communities from Lead Hazards: A Guide for Protective Work Practices and Effective Worker Training." The document was developed to protect workers and community health during lead-based paint abatement

Past Vice Chair, Tennessee Air Pollution Control Board

Past Member, Editorial Review Board for Asbestos Abatement

Past Member, Editorial Review for the National Asbestos Council Journal

Past Chair, The Lewis Society (Vanderbilt University, School of Engineering)

Past President, Vanderbilt University Engineering Alumni Council

Past Member, Vanderbilt University Alumni Board of Directors

Past President, Consulting Engineers of Tennessee

Past Co-Chair, Nashville Mayor Richard Fulton's Task Force to Improve Building Code Department Operations

Past Chair, Nashville Mayor Fulton's Rehabilitation Building Code Task Force

Past Member, State of Tennessee's Insurance Commissioner's Review Panel on Tennessee Building and Fire Codes as a representative of Tennessee Society of Professional Engineers

PRESENTATIONS:

"Mesothelioma Dose Reconstruction from the Experts Perspective", presented at The Environmental Institute, April 8, 2010.

"Mesothelioma Dose Reconstruction from the Experts Perspective", presented at EIA Austin Conference 2010, March 31, 2010.

"Nanotubes", co-presenter at EIA Nashville 2009 Conference, March 2009

"Asbestos Exposure for oil Drilling Mud Additives", presented at EIA Albuquerque 2008 Conference, March 21, 2008.

"Nanotechnology-Research Laboratories and EHS Issues", presented to EIA Albuquerque 2008 Conference, March 17, 2008.

Educational Session for Vanderbilt University School of Engineering, November 14th, 2007

"Sick Building Syndrome", presented to the Academy of Psychiatry and the Law, October 18, 2007.

"Moisture and Mold Management", presented to Marriott 2007 Central Region Engineering Conference, September 6 -7, 2007.

"Forensic Architecture and Environmental, Health, and Safety Services" presented to Sunrise Senior Living, May 31, 2007.

"Nanotechnology Research Laboratories and EHS Issues" presented at the EIA Conference March 19, 2007.

Review and update of Project Designer Issues, presented at The Environmental Institute November 29, 2006.

Review and Update of Asbestos Inspector Issues, presented at The Environmental Institute November 28, 2006.

"Post-Remediation for Lead," presented at the American Industrial Hygiene

Conference & Exposition, Chicago, IL, May 17, 2006.

"The Technical Aspects of The Meth Issue," presented at the Twenty-Third Annual Conference and Exposition of the Environmental Information Association, Phoenix, AZ, March 27, 2006.

"Chemical Engineering '73,"presented to Vanderbilt University School of Engineering, Nashville, TN, November 16, 2005.

"The Creation by Professionals of a Remediation Plan," presented at the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by Ecobuild America), Orlando, FL, June 21, 2005.

"Interpretation of South Texas Airborne Fungi Data," podium session presented at the American Industrial Hygiene Conference and Exposition, Anaheim, CA, May 23, 2005.

"Manganese in Welding Fume," presented at the Twenty-Second Annual Conference and Exposition of the Environmental Information Association, New Orleans, LA, March 23, 2005.

"Industrial Hygiene Perspective," presented at Mealey's Welding Rod Litigation Conference, West Palm Beach, FL, October 7, 2004.

"Mold Amplification Associated with New Construction," presented at the 2004 Boulder Conference, *Mold in the Indoor Environment: Assessment, Health and Physical Effects, and Remediation* (sponsored by ASTM), Boulder, CO, July 26, 2004.

"Buildings and Mold Alliance Update," developed for the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by the Building Environment and Thermal Envelope Council), Chicago, IL, July 15, 2004.

"The Creation by Professionals of a Remediation Plan," presented at the conference, M6: Mold, Moisture, Misery, Money and Myth – Plus Management (sponsored by the Building Environment and Thermal Envelope Council), Chicago, IL, July 15, 2004.

"Welding Processes and Government Regulations," presented at the conference, Welding Rods: An In-Depth Look at Emerging Litigation (sponsored by HarrisMartin Publishing), San Francisco, CA, June 16, 2004.

"A Study of Exposure to Manganese in Welding Fume and Characterization of the Manganese in the Fume," presented at the Conference on Health Effects of Manganese: Research, Industrial Hygiene, and Clinical Issues in Occupational Exposures, New Orleans, LA, April 18, 2004.

"Mold, the National Institute of Building Sciences, and Environmental Safeguards," presented to the Environmental Bankers Association, San Antonio, TX, January 20, 2004.

"Industrial Hygiene Measurements of Total Fume and Manganese Exposures to Welders," presented at the conference, Manganese Exposure in Welders: Health Effects, Clinical Outcome, Research Methods (sponsored by the California Department of Health – Occupational Health Branch), Oakland, CA, August 1, 2003.

"Executive Summary; Mold and the Hospitality Industry," presented to executives of Marriott International, Inc., Bethesda, MD, June 27, 2003.

"The Indoor Environment (Indoor Air Quality and Mold)," presented at BOMA luncheon, Austin, TX, June 19, 2003.

"Mold Remediation: Just Clean It Up?," presented at Mold Litigation: Beyond the Basics II (sponsored by HarrisMartin Publishing), New Orleans, LA, June 13, 2003.

"Health Issues: Toxicity, Occupancy, and Air Quality," presented at BETEC 2003 Spring Symposium, Washington, DC, June 5, 2003.

"What Industrial Hygienists Need to Know About Buildings and Construction to Identify and Resolve IEQ Problems," professional development course presented at the American Industrial Hygiene Conference and Exposition, Dallas, TX, May 11, 2003.

"The Indoor Environment (IAQ, Mold, and Terrorism)," presented at the 2003 National Property Management Conference, sponsored by USAA Realty Company, San Antonio, TX, March 28, 2003.

"Asbestos in Surface Dust – Lessons from New York and Elsewhere," professional development course presented at the 20th Annual Conference and Exposition of the Environmental Information Association, Savannah, GA, March 23, 2003.

"When AHERA Does Not Make Sense," forum presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA, June 3, 2002.

"What Industrial Hygienists Need to Know About Building and Construction to Identify and Resolve IEQ Problems," professional development course presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA, June 2, 2002.

"The Science and Art of Environmental Mold Investigations," lecture presented at *Mold Medicine & Mold Science, Its Practical Applications for Patient Care*, hosted by the International Center for Toxicology and Medicine (ICTM) and the Department of Pharmacology at Georgetown University, Washington, DC, May 14, 2002.

Roundtable I and Roundtable II, discussions at *Mold Medicine & Mold Science, Its Practical Applications for Patient Care*, hosted by the International Center for Toxicology and Medicine (ICTM) and the Department of Pharmacology at Georgetown University, Washington, DC, May 13 and 14, 2002.

“OSHA Standards for Science Labs,” lecture presented to the Tennessee Board of Regents, Nashville, TN, April 17, 2002.

"Mold Investigations for Insurance Claims in South Texas," lecture presented at the 19th Annual Conference and Exposition of the Environmental Information Association, San Antonio, TX, March 27, 2002.

“Building Construction, Systems, and Moisture,” lecture presented at the USAA Realty Company 2001 National Management Conference, San Antonio, TX, November 13, 2001.

“Lead Hazard Evaluation and Control in Buildings Using ASTM E 2052-99,” professional development course presented at the American Industrial Hygiene Conference and Exposition, New Orleans, LA, June 2, 2001. Co-presenter.

“Indoor Air Quality; Typical Problems and Solutions,” lecture presented at the USTA Environmental Conference and Showcase, Dallas, TX, May 22, 2001.

“What Industrial Hygienists Need to Know About Buildings and Construction,” lecture presented at the 18th Annual Conference and Exposition of the Environmental Information Association, Phoenix, AZ, March 25, 2001.

“Introduction to Indoor Air Quality,” “EPA’s Tools for Schools Action Kit,” and “Maintaining IAQ During Renovations,” lectures presented at “Indoor Air Quality Tools for Schools” seminar sponsored by the Colorado Department of Public Health and Environment, Denver, CO, June 1, 2000.

“Lead Hazard Management Program Training for U.S. General Services Administration Employees,” lecture prepared for the American Industrial Hygiene Conference and Exposition, Orlando, FL, May 22, 2000.

"Indoor Air Quality 101," lecture presented to the Association of School Business Officials International conference, Orlando, FL, October 18, 1999.

"Insuring Accuracy in Indoor Air Quality Investigations Involving Microbial Contamination," lecture presented to the National Environmental Health Association's Indoor Air Quality conference, Nashville, TN, July 7, 1999.

“Application of ASTM D-5755 for Measurement of Asbestos in Settled Dust to Assess Contamination and Clear Abatement Projects,” lecture presented at the American Industrial Hygiene Conference and Exposition, Toronto, Ontario, Canada, June 10, 1999.

"Lead Hazard Management Program Training for U.S. General Services Administration Employees," lecture presented at the American Industrial Hygiene Conference and Exposition, Toronto, Ontario, Canada, June 7, 1999.

"Healthy School Environments; Cleaning and Maintenance Strategies," lecture presented at Indoor Environment 99, Austin, TX, April 21, 1999.

"Engineering Insight Into Why Buildings Can Make Your Patients Sick," lecture presented to Tennessee Thoracic Society, Vanderbilt University, April 10, 1999.

"Indoor Air Pollution," lecture presented to the Department of Civil and Environmental Engineering, Vanderbilt University, April 5, 1999.

"Environmental Chemistry for the Scientifically Challenged," lecture presented at the 16th Annual Conference and Exposition of the Environmental Information Association, San Antonio, TX, March 29, 1999.

"Indoor Air Quality in Chemistry Laboratories," lecture presented at The Pittsburgh Conference (Pittcon '99), Orlando, FL, March 10, 1999.

"Indoor Air Quality," lecture presented to the Tennessee Board of Regents, November 19, 1998.

"Programming for Laboratory Design," lecture presented to the Tennessee Board of Regents, Nashville, TN, November 18, 1998.

"Identification of and Testing for Lead Hazards: Transforming Inspection and Assessment Results into Action," lecture presented at Lead Tech '98 Conference & Exhibition, October 26, 1998.

"Identification of and Testing for Lead Hazards," lecture presented at the 1998 National Lead Grantee Conference, Phoenix, AZ, June 23, 1998.

"Environmental Chemistry for the Scientifically Challenged," lecture presented at the Institute of Real Estate Management, Las Vegas, NV, June 20, 1998.

"Solving a Serious Indoor Air Quality Problem with Electron Microscopy Analysis," lecture presented at the American Industrial Hygiene Conference and Exposition, Atlanta, GA, May 13, 1998.

"IAQ Tools for Schools," lecture presented at School Air Quality and Asthma Workshop, (cosponsored by the U.S. Environmental Protection Agency), April 29, 1998.

"Maintaining Acceptable IAQ During Renovations," lecture presented at Indoor Environment '98, April 16, 1998.

"Bioaerosol Exposures in Multi-Building Complex with Significant Water Infiltration," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 25, 1998.

"Using Pilot Projects to Determine Proper Methods for Lead-Based Paint Abatement in Housing Authority Projects," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 24, 1998.

"Criminal Proceedings in Federal Court: How Not to Remove Asbestos," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 23, 1998.

"Worker Health and Safety: A Brief Historical Perspective," lecture presented at the 15th Annual Conference and Exposition of the Environmental Information Association, March 23, 1998.

"Worker Lead Safety - Current Methods in Prevention & Control, Part I," lecture presented at Lead Tech '97 Conference & Exhibition, October 1, 1997.

"Incorporating Dust Sampling Into the Asbestos Management Program," lecture presented at ASTM's Boulder Conference, July 17, 1997.

"Top 10 Controversies in the Indoor Environment," lecture presented at Indoor Environment '97: Setting the Standard for Healthy Building Management, April 7, 1997.

"Asbestos Dust Contamination - How Much is Too Much?" Professional Development Seminar: 14th Annual Conference and Exposition of the Environmental Information Association, March 23, 1997. Co-Presenter.

"Pesticide Exposures Related to Construction Activities," presented at the American Industrial Hygiene Association/Indiana Section, March 19, 1997.

"Managing an Effective Environmental, Health, and Safety Program", lecture presented at the American Industrial Hygiene Conference and Exposition, Washington, D.C., May 23, 1996.

"Questions of Risk Management in Schools and Public Buildings: The American Experience," lecture presented at Amiante (Paris, France), April 26, 1996.

"The Top Five IAQ Controversies: What Every Professional Should Know," lecture presented at the American Industrial Hygiene Association/Indiana Section, February 13, 1996.

"The Top Ten IAQ Controversies: What Every Professional Should Know," lecture presented at Indoor Environment '95: Strategies for the New Era of Regulation, May 2, 1995.

"NIBS Lead-Based Paint Operations and Maintenance Manual Development and Use," lecture presented at the Twelfth Annual Conference and Exposition of the Environmental Information Association, April 25, 1995. Co-Presenter.

"Asbestos O&M Practices and Procedures at EPA Occupied or Controlled Facilities," lecture presented at the Twelfth Annual Conference and Exposition of the Environmental Information Association, April 24, 1995. Co-Presenter.

"U.S. EPA Lead Regulations and Activities: A Question and Answer Session," Twelfth Annual Conference and Exposition of the Environmental Information Association, April 24, 1995. Co-Presenter.

"Indoor Air Quality: Solutions and Strategies," Professional Development Seminar: Twelfth Annual Conference and Exposition of the Environmental Information Association, April 22, 1995. Co-Presenter.

"Sampling and Analysis for Asbestos in Settled Dust," Professional Development Seminar: Twelfth Annual Conference and Exposition of the Environmental Information Association, April 22, 1995. Co-Presenter.

"Interpretation of Scientist's Needs and Wants," lecture presented during the Architect/Engineer In Laboratory System Design session at the American Society of Heating, Refrigerating and Air Conditioning Engineers' Winter Conference, January 29, 1995. Presenter.

"Indoor Air Quality," lecture presented to the Nashville Chapter of the American Institute of Architects. August 11, 1994.

"OSHA Indoor Air Quality Proposed Rule," seminar conducted by Gobbell Hays Partners, Inc. June 14, 1994.

"Investigation of Health Effects Complaints from Construction Workers at a Large Wastewater Treatment Plant," poster presentation at the American Industrial Hygiene Conference and Exposition, Anaheim, California. May 24, 1994. Co-Presenter.

"Developing a Scope of Work, Planning and Initiating the Phase I Environmental Site Assessment," lecture presented during the Professional Development Seminar <u>Conducting Environmental Site Assessments: The ASTM Standard and Beyond</u> at the American Industrial Hygiene Conference and Exposition. May 21, 1994.

"Strategies and Resources for Solving Indoor Air Quality Problems," lecture presented to Vanderbilt University Engineering Department. March 31, 1994.

"Conducting Indoor Air Quality Investigations: A Basic Primer," session presented at EM '94, the Environmental Information Association's Annual Conference and Exposition. March 14, 1994. Co-presenter.

"Settled Asbestos Dust Sampling and Analysis," Professional Development Seminar presented at EM '94, the Environmental Information Association's Annual Conference and Exposition. March 13, 1994. Co-presenter.

"Indoor Air Quality and Other Environmental Hazards," presentation at Willis Corroon's Environmental Risk Management Services' Broker Training Seminar, Nashville, Tennessee. February 1, 1994.

"Issues in Industrial Hygiene," session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"Overview and Analysis of Lead Abatement Methods," session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"Defining the Lead Detection and Abatement Industry," general session presented at Lead Tech '93 Conference and Exposition. October 28, 1993. Co-Presenter.

"The Asbestos Operations and Maintenance Program," session presented at the 48th Annual Federal Safety and Health Conference, Chicago. October 6, 1993.

"Building Engineering in Today's Marketplace," lecture presented at Tennessee Technological University. September 10, 1993.

"What to Expect from an Environmental Site Assessment: Part I - What to Look For," lecture presented for Georgia Tech to the BellSouth Corporation. August 31, 1993.

"What to Expect from an Environmental Site Assessment: Part II - What Do Results Mean," lecture presented for Georgia Tech to the BellSouth Corporation. August 31, 1993.

"Development of Health Protection Recommendations for CFC Replacement," presented to the American Industrial Hygiene Conference and Exposition. May 15- 21, 1993. Co-Presenter.

"Exposure Modeling for a Coolant to Replace CFC's in an Industrial Process," presented to the American Industrial Hygiene Conference and Exposition. May 15- 21, 1993. Co-Presenter.

"Data Evaluation and Report Writing," lecture presented during the Professional Development Seminar Conducting Environmental Evaluations: An Overview at the American Industrial Hygiene Conference and Exposition. May 15, 1993.

"ASTM Guide for Evaluation of Asbestos on Surfaces," lecture presented at the ASTM Conference. April 25, 1993.

"The Scope of Indoor Air Quality Problems," session presented at Indoor Environment '93. April 22, 1993.

"Managing IAQ During Building Renovation," session presented at Indoor Environment '93. April 21, 1993.

"Lead-Based Paint Design Strategies," training course conducted for the Memphis Naval Air Station, Millington, Tennessee. April 20-22, 1993. Co-Presenter.

"Case Study: HVAC Modifications for Asbestos Operations and Maintenance Purposes," poster session presented to the Health Effects Institute. March 8 - 9, 1993. Co-Presenter.

"Operations and Maintenance Programs in Buildings Containing Asbestos: A Workshop," presented to the Health Effects Institute. March 8, 1993.

"Level of Effort Required for Operations and Maintenance Work Practices," presented to the Health Effects Institute. March 8 - 9, 1993. Co-Presenter.

"Lead Abatement Strategies and Techniques," lecture presented at Lead in Charleston: Conference for Contractors. March 4, 1993.

"Writing Specifications for Lead Based Paint Projects," lecture presented at Lead Tech '92. October 2, 1992.

"NAC/The Environmental Information Association's Role in Development of a Lead Based Paint Abatement Infrastructure," lecture presented at Lead Tech '92. October 2, 1992.

"Occupational Exposure to Inorganic Lead," lecture presented at Lead Tech '92. September 30, 1992. Co-Presenter.

"The Use of Settled Dust in the Development of Asbestos Control Programs," lecture presented at the Johnson Conference. July 15, 1992. Co-Presenter.

"Lead-Based Paint Abatement: Learning the Lessons from the Asbestos Experience," roundtable session held at the American Industrial Hygiene Conference and Exposition. June 2, 1992. Co-Presenter.

"Data Evaluation and Report Writing," lecture presented during the Professional Development Seminar Conducting Environmental Evaluations: An Overview at the American Industrial Hygiene Conference and Exposition. May 30, 1992.

"Chemical and Laboratory Considerations," lecture presented during the Professional Development Seminar Conducting Environmental Evaluations: An Overview at the American Industrial Hygiene Conference and Exposition. May 30, 1992.

"Health Implications and Regulations in Asbestos Abatement," lecture presented to the Industrial Fabrics Association International. October 20, 1991. Co-Presenter.

"Asbestos: Legal Concerns," lecture presented at Selected Topics in Occupational Medicine Conference. September 14, 1991.

"Managing Asbestos in Place," lecture presented for the Environmental Protection Agency Safety, Health and Environmental Management Compliance Annual Conference. June 27, 1991.

"What is an O&M Program? What Training is Necessary?" lecture presented at Implementing Operation and Maintenance Programs for Asbestos-Containing Materials, sponsored by USEPA. June 4, 1991.

"What Does an O&M Program Include?" lecture presented at Implementing Operation and Maintenance Programs for Asbestos-Containing Materials, sponsored by USEPA. June 4, 1991.

"Asbestos at a Fire Scene," lecture presented at the Emergency Response Conference. April 5, 1991. Co-Presenter.

"Sick Building Syndrome: An Overview," lecture presented during the Minimizing Environmental Risk in Building Operation and Property Transfer session at the National Asbestos Council, Inc. Eighth Annual Asbestos Management Conference and Exposition. February 19, 1991.

"Interpreting the Results of an Environmental Audit Site Assessment," lecture presented during the Minimizing Environmental Risk in Building Operation and Property Transfer session at the National Asbestos Council, Inc. Eighth Annual Asbestos Management Conference and Exposition. February 19, 1991.

"Recent Research on Fiber Release from Asbestos-Containing Material and Re-entrainment of Asbestos Dust," session presented to The Third Wave of Asbestos Disease: Asbestos in Place, a conference under the auspices of the Collegium Ramazzini. June 1990. Co-Presenter.

"Recent Research on Fiber Release from Asbestos-Containing Material and Re-entrainment of Asbestos Dust," session presented to the National Asbestos Council, Inc. Seventh Annual Asbestos Abatement Conference and Exposition. February 1990. Co-Presenter.

"Point ... Counterpoint: When is the Right Time to do Removal," session presented to the National Asbestos Council, Inc., Seventh Annual Asbestos Abatement Conference and Exposition. February 1990. Co-Presenter.

"Replacement Materials: How to Avoid the Pitfalls," session presented to the Asbestos Abatement Council of the Association of the Wall and Ceiling Industries -International. January 1990. Co-Presenter.

"Experimental Data for Project Design," 1989 session for the National Asbestos Council, Fall Technical Conference and Exposition. Co-Presenter.

"Mechanical Engineering and Asbestos Abatement Design," 1989 session for the National Asbestos Council, Sixth Annual Asbestos Abatement Conference and Exposition. Co-Presenter.

Testimony given before the Joint Hazardous Waste Committee, State of Tennessee, 1989.

"Executive Summary: Asbestos in Buildings," a joint seminar conducted by Gobbell Hays Partners, Inc. and Environmental Sciences, Inc., March 1989.

"Beyond AHERA - Building Inspection From the Designer's Point of View," 1988 session for the National Asbestos Council Fall Technical Conference and Exposition.

"Certification of Designers According to AHERA," 1988 session for the National Asbestos Council, Fifth Annual Asbestos Abatement Conference and Exposition. Co-Presenter.

"Asbestos Hazard Assessment," Association of the Wall and Ceiling Industries - International, Asbestos Abatement World Congress and Exposition, June 1987.

"Asbestos Abatement in Schools and Government Buildings," Association of the Wall and Ceiling Industries - International, Asbestos Abatement World Congress and Exposition, January 1987.

"Contracting Asbestos-Related Work" and "Operations and Management," building owners, managers, contractors and architects, University of Kentucky-Lexington, October 1984; October 1985; November 1986; October 1987.

Operations and Maintenance Training for maintenance workers, and Asbestos Awareness Training for administrative officials and custodians at Evanston Township High School, Evanston, Illinois, 1986.

Asbestos awareness seminar for Indiana School Superintendents, 1986.

"Contract Specifications," EPA Regional Asbestos Coordinators, Georgia Institute of Technology, December 1985.

"Guidelines Specifications as Produced by the National Institute of Building Sciences," University of Kansas, October 1985.

"Asbestos Concerns," Nashville Chapter of Risk and Insurance Managers Society, Nashville, Tennessee, November 1985.

"Asbestos in the Built Environment," U.S. House of Representatives Committee on Appropriations, the Subcommittee on HUD and Independent Agencies, Washington, D.C., 1984.

EXPERT TESTIMONY:

Testified before a committee of the Texas Senate - "Dose Reconstruction for Mesothelioma Victims" – March 23, 2009.

Testified before a committee of the Texas House - "Dose Reconstruction for Mesothelioma Victims" – March 30, 2009.

PAPERS/PUBLICATIONS:

"Zonolite Attic Insulation Exposure Studies", International Journal of Occupational and Environmental Hygiene, Volume 16, Issue 3, July/September 2010, Co-Author.

Industry Views: the Best and Worst of IAQ in 2009, Indoor Environment Connections, Volume 12, Issue 2, December 2009. Quoted

"Analysis of Carbon Nanotubes in Air", The Microscope, Volume 57:3, 2009, Co-Author.

"Mold 'Remediation'? Just Clean It Up! An Industrial Hygienist's Perspective," Columns, February 2004, Author.

"Best and Worst of IAQ in 2003," Indoor Environment Connections, December 2003. Featured and quoted.

"Indoor Air Quality in Chemistry Laboratories," American Laboratory, August 2000. Author.

"Local Engineer Leader in HUD Healthy Homes Study," Nashville Business Journal, January 8 - 14, 1999. Featured and quoted.

"Building Bridges to Academe," American Consulting Engineer, August/September 1998. Quoted.

"Poor Indoor Air Can Cause Health, Productivity to Suffer," Nashville Business Journal, July 28 - August 1, 1997. Featured and quoted.

"Lack of Standards, Regulation in IAQ Industry Creates Confusion for Building Managers," Indoor Environment Review, July 1997. Quoted.

"HVAC Design Tops IAQ Controversies For 1997," Indoor Environment Review, May 1997. Featured and quoted.

"Asbestos-Containing Sheet Gaskets and Packing," Asbestos Health Risks: Sourcebook on Asbestos Diseases (Volume 12), Michie Publishers, 1996. Co-Author.

"The Management of the Asbestos Risk in Schools and Public Buildings: American Experience," Pollution Atmospherique, July - September 1996. Author.

"Releasability of Asbestos Fibers From Asbestos-Containing Gaskets," EIA Technical Journal, Fall 1995. Co-Author.

"Architectural Firm Forms Environmental Unit," Nashville Business Journal, July 3-7, 1997. Featured and quoted.

"Development and Use of The National Institute of Building Sciences' Lead-Based Paint Operations & Maintenance Manual," EIA Technical Journal, Fall 1995. Co-Author.

Indoor Air Quality: Solutions and Strategies, McGraw-Hill Publishers, 1995. Co-Author.

"National Institute of Building Sciences: Recommended Practices and Procedures for Operations and Maintenance" Applied Occupational Environmental Hygiene, November 1994. Author.

"Baseline Studies of Asbestos Exposure During Operation and Maintenance Activities" Applied Occupational Environmental Hygiene, November 1994. Co-Author.

"Level of Effort Required for Operations and Maintenance Work Practices", Applied Occupational Environmental Hygiene, November 1994. Co-Author.

"Synthesis, Summary and Outlook", Applied Occupational Environmental Hygiene, November 1994. Panelist

"Determining the Bottom Line in Indoor Air," Indoor Air Review, June 1994.

Settled Asbestos Dust Sampling and Analysis, Lewis Publishers, 1994. Co-Author.

"PC is Critical for Asbestos Abatement," Safety and Protection Fabrics, February 1994. Co-Author.

"Shelter from Liability When Disaster Strikes a Building," Indoor Pollution Law Report, May 1993.

"Asbestos Exposure During and Following Cable Installation in the Vicinity of Fireproofing," Environmental Choices Technical Supplement, March/April 1993. Co-Author.

"Problem Solving Forum: Asbestos in Coatings," Journal of Protective Clothing and Linings, February 1993.

"Ventilation an Important Part of Mitigating Indoor Air Quality in Laboratories," Indoor Air Review, December 1992.

"Re-entrainment of Asbestos from Dust in a Building with Acoustical Plaster," Environmental Choices Technical Supplement, July/August 1992. Co-Author.

"Protective Clothing in the Asbestos and Lead Abatement Industries," paper presented at Sixth Annual Conference on Protective Clothing, Clemson University. May 6, 1992.

"How to Attack IAQ Problems," Heating/Piping/Air Conditioning, April 1992. Co-Author.

"Air and Dust Sampling in Return Air Plenums," paper presented at the National Asbestos Council, Inc.'s Conference, April 1992.

"Use of Observational Data and Experimental Studies in Developing Better O&M Plans," paper presented at the National Asbestos Council, Inc.'s Conference, April 1992. Co-Author.

"Exposure to Airborne Asbestos Associated with Simulated Cable Installation Above a Suspended Ceiling," Journal of the American Industrial Hygiene Association (JAIHA), November 1991. Co-Author.

"Reliance on Asbestos Consultants," Sourcebook on Asbestos Diseases: Medical, Legal, and Engineering Aspects, Volume 5, published 1991 by Butterworth Legal Publishers. Co-Author.

"Airborne Levels During Non-Friable Asbestos-Containing Material Removal," 1990 paper for the National Asbestos Council, Inc., Fall Technical Conference and Exposition. Co-Author.

"Asbestos at a Fire Scene: The Case of the Dupont Plaza Hotel," Fire Journal, March/April 1990.

"Decon: A Case Study in Technology," Asbestos Issues, February 1990. Co-Author.
"Replacement of Asbestos-Containing Materials," Asbestos Abatement, January/February 1990.

"Surface Contamination: A Case Study of a Comprehensive Approach," 1989 paper presented to the National Asbestos Council, Fall Technical Conference and Exposition. Co-Author.

"Mechanical Engineering and Replacement Design," paper presented to the National Asbestos Council, Sixth Annual Asbestos Abatement Conference and Exposition. Co-Author.

"Designing and Construction of an Asbestos Microscopy Laboratory Facility," Microscope, 1989. Co-Author.

"Designing a Transmission Electron Microscopy (TEM) Laboratory," NAC Journal, Spring 1988.

"The Importance of Dimensional Accountability," Asbestos Abatement, September/October 1988.

"Designing a Transmission Electron Microscopy (TEM) Laboratory," 1988 paper for the National Asbestos Council, Fall Technical Conference and Exposition. Co-Author.

"Dimensional Accountability," paper presented to the World Congress II and Exposition on Asbestos Abatement, The Asbestos Abatement Council of AWCI, May 1988. Co-Author.

"Writing Specifications for Asbestos Abatement Projects," 1988 Directory for National Insulation Contractors Association.

"A Chemical Engineer's Role in the Building Industry," Chemical Engineering, January 18, 1988.

"Case Study: Asbestos Abatement of Steam Generating Plant, Jacksonville, Florida," 1987 paper for the National Asbestos Council, Fall Technical Asbestos Abatement Conference and Exposition.

"Removing Asbestos-Containing Fireproofing, Anchorage, Alaska School Project," Insulation Outlook, March 1987.

"Asbestos Abatement and Removal, Bartlett High School, Anchorage, Alaska," 1986 paper for the National Asbestos Council, Third Annual Asbestos Abatement Conference and Exposition. Co-Author.

"Hazard Assessment: A Summary," Inter/Micro '86 (an international symposium of microscopists and scientists).

"Asbestos Removal in Public Schools," Inter/Micro '82.

AWARDS:

The Indoor Environment Quality Committee Past Chair Recognition of Excellence Award, presented at the American Industrial Hygiene Association Conference and Expo, May 2006.

Inducted into the College of Fellows of the American Consulting Engineers Council (now known as the American Council of Engineering Companies), October 1, 1999.

President's Citation Award for Outstanding Service, presented by the Consulting Engineers of Tennessee, 1991.

Outstanding Long-Range Planning Award, presented by the Consulting Engineers of Tennessee, 1990.

President's Award, presented by the Consulting Engineers of Tennessee, 1982.
President's Citation, presented by the Tennessee Society of Professional Engineers, 1981.

Tennessee Young Engineer of the Year, presented by the Tennessee Society of Professional Engineers, 1981.

Young Engineer of the Year, presented by the Tennessee Society of Professional Engineers-Nashville Section, 1981.

President's Award, presented by The Environmental Information Association, 1993/1994.

COURSES/SEMINARS:

Asbestos/Supervision

Supervision of Asbestos Abatement Projects: Course and Workshop/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, or Pioneer Environmental in 1989, 1991, 1993, 1994, 1995, 1996, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006

Asbestos/Inspection

Inspecting Buildings for Asbestos-Containing Materials/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, the University of Cincinnati, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006

Asbestos/Management Planning

Managing Asbestos in Buildings/1987, Georgia Tech Research Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, the University of Cincinnati, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006

Asbestos/Abatement Design

Asbestos in Buildings: Designing the Abatement Project/1988, The Environmental Institute

Refresher courses taken at Georgia Tech Research Institute, The Environmental Institute, or Pioneer Environmental in 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006

Additional Courses

Florida Building Code – Building/Fire Safety/2003, American Institute of Architects & Tennessee Society of Professional Engineers

Air Monitoring Technician Refresher/2005, Pioneer Environmental

Mold Assessment and Remediation in Buildings/2001, The Environmental Institute

Lead Abatement Supervisor: EPA (Target Housing & Child-Occupied Facilities)/1999, The Environmental Institute

Lead-Based Paint Abatement Design Strategies/1998, Georgia Tech Research Institute

Lead Abatement for Supervisors and Contractors/1995, Georgia Tech Research Institute

Settled Dust Sampling: Asbestos and Other Particulates/1991, Georgia Tech Research Institute

Comprehensive Review for Industrial Hygiene Professionals/1990, University of Cincinnati Institute of Environmental Health

Respiratory Protection for Asbestos Abatement Projects/1989, The Environmental Institute

Hazardous Material Control & Emergency Response/1987, Georgia Tech Research Institute

AFFILIATIONS:

The Environmental Information Association (EIA)
American Academy of Industrial Hygiene (AAIH)
American Industrial Hygiene Association (AIHA)
National Institute of Building Sciences (NIBS)
American Council of Engineering Companies (ACEC)
Consulting Engineers of Tennessee (CET)
American Society for Testing and Materials (ASTM)
Air and Waste Management Association (AWMA)
American Conference of Governmental Industrial Hygienists (ACGIH)
The International Society of Indoor Air Quality and Climate (ISIAQ)

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APPENDIX C

Expert Testimony Experience Since 1999 – Steve M. Hays, PE, CIH

Client or Attorney & Location	Case Number	Names of Parties	Where Case was Filed	Deposition	Trial	GHP Project Number
Law Offices of Martin Dies State of Hawaii Orange, TX	93-4161-10	State of Hawaii vs. W.R. Grace & Co. – Conn., a Connecticut Corporation	Circuit Court of the First Circuit, State of Hawaii	Yes 9/21/1999	No	00068.00
Law Office of Chris Grant Falls Church, VA	ASBCA Nos. 52145, et al.	The Sherman R. Smoot Construction Co. vs. U.S. Navy	Armed Services Board of Contract Appeals Falls Church, VA	Yes 10/15/2001	Yes 11/19/01	01052.00
Peter G. Angelos Law Offices Baltimore, MD	Consolidated Case No. 24-X-01-000921	Luther Brill, et al. vs. ACandS, Inc. et al.	Circuit Court for Baltimore City	Yes 1/25/2002	No	01110.00
Peter G. Angelos Law Offices Baltimore, MD	Consolidated Case No. 24-X-01000915	John James, et al. vs. ACandS Inc, et al.	Circuit Court for Baltimore City	Yes 7/19/2002	No	01110.XX
Peter G. Angelos Law Offices Baltimore, MD	C.A. No. 00C-02-053	Apostal Trial Group vs. Stroz Trial Group, Vol. I	Superior Court of the State of Delaware in and for New Castle County	Yes 10/22/2001	No	01110.XX

Peter G. Angelos Law Offices Baltimore, MD	C.A. No. 00C-02-053	Apostal Trial Group vs. Stroz Trial Group, Vol. II	Superior Court of the State of Delaware in and for New Castle County	Yes 10/22/2002	No	01110.02
Peter G. Angelos Law Offices Baltimore, MD	C.A. No. 01C-10-063	Carl Roca, ET UX vs. Daimler Chrysler, et al.	Superior Court of the State of Delaware in and for New Castle County	Yes 6/7/2002	No	01110.XX
Alkon, Rhea & Hart Christiansted, St. Croix U.S. Virgin Islands	Asbestos Docket Master Docket 324/1997	Virgin Islands Asbestos Cases (subject to change)	Territorial Court of the Virgin Islands Division of St. Croix at Kingshill	Yes 8/22/02 10/31/2002	No	03088.00
Turley, Swan & Childers Phoenix, AZ	CV2001-016699	Builders National, et al. adv. Crystal Breeze	Superior Court of the State of Arizona in and for the County of Maricopa	Yes 12/3/2002	No	02123.00
Roussel & Roussel La Place, LA	99-12527	John and Josephine Murden vs. ACandS Inc. et al	Civil District Court for the Parish of Orleans, State of Louisiana	Yes 2/24/2003	No	02073.00
Haftel & Silverman New York, NY	Case # 02CV10340	Maxwell Partners vs. Twin City Fire Insurance Company	Southern District Court of New York New York, NY	Yes 4/2/2003	No[1]	03023.00

Richardson, Patrick, Westbrook, & Brickman, LLC Mount Pleasant, SC	Case No. 01-01139 (JFK)	W.R. Grace & Co., et. al., Debtors	US Bankruptcy Court for the District of Delaware	Yes 5/7/2003	Pending	02031.00
Akin Gump Strauss Hauer & Feld San Antonio, TX	C.A. No. M-02-105	Linda Flores v. State Farm Lloyds	US District Ct. for the Southern District of Texas McAllen Div.	Yes 9/26/2003	No	02044.06
Akin Gump Strauss Hauer & Feld San Antonio, TX	C.A. No. M-02-070	Jose and Martha Salinas v. State Farm Lloyds	US District Ct. for the Southern District of Texas McAllen Div.	Yes 9/26/2003	No	02044.04
Dogan & Wilkinson, PLLC Pascagoula, MS	Cause No. 23941*BH03	Howard & Mary Jo Peterson v. Ashland, Inc. et.al,	District Court of Brazoria County, Texas 23rd Judicial District	Yes 04/13/2004	No	04020.00
Haftel & Silverman New York, NY				Yes 09/27/2004		03023.00
Roussel & Roussel La Place, LA	2003 - 10743	Russo, Granier, Herbert, Danos v. Avondale Industries, Air Products and Chemicals, Inc.	Civil District Court for the Parish of Orleans, State of Louisiana	Yes 3/15/2005	No	02073.02
Dogan & Wilkinson, PLLC Pascagoula, MS	Cause No. 2006-41943	Charles White & Barbara Lorton vs. Buffalo Pumps, Inc., ET AL	District Court of Harris County, Texas 11th Judicial District	3/9/2007	No	06104.02

Caplin & Drysdale Washington, DC	Case No. 01-1139 (JFK)	CHAPTER 11 IN RE: W. R. GRACE & CO., et al., Debtors	U. S Bankruptcy Court for the District of Delaware	Yes 10/22/2007	Pending	05110.01
Simon Eddins & Greenstone, LLP Dallas, Texas	No. 0703-03575	Marilyn Stratton and Richard Stratton v. Bondex International, Inc., et al.	Circuit Court for the State of Oregon, for the County of Multnomah	No	Yes Testimony On January 14 and 15, 2008	07079.03
Simon Eddins & Greenstone, LLP Dallas, Texas	No. BC 351481	Lemkin vs. Georgia Pacific Corporation, et al.	Superior Court of the State of California, for the County of San Francisco	Yes 02/01/2008	No	07079.00
Simon Eddins & Greenstone, LLP Dallas, TX	No. 2006-64193	Lessie Lewis	In the District Court Harris County, Texas 11th Judicial District	Yes 11/27/2007	Yes	07079.02
Caplin & Drysdale Washington, DC	Case No. 01-1139 (JFK)	W.R. Grace Bankruptcy	United States Bankruptcy Court for the District of Delaware	Yes 10/22/2007	No	05110.01
Sales, Tillman, Wallbaum	Case No. 07-CI-05178	Delores Robertson v. CSX Transportation, et al.	In the Circuit Court for Jefferson County, Division Eight	Yes 10/09/2008		08112.00
Brent Coon and Associates, PC	Case No. CV-06-147	Karen Mae Huffman v. Allied Glove Corporation	In the Court of Common Pleas, Morgan County, Ohio	Yes 10/21/2008		08111.00

Brent Coon and Associates, PC	Cause No. CV-2006-0177-6	Virginia Lee Huffman v. A.W. Chesterton Co., et al.	In the Court of Union County, Arkansas Civil Division	Yes 11/21/2008		08111.03
Martzell & Bickford	No. 558-482	Kermit Richard, et al. v. Anco Insulators, Inc., et al.	19th Judicial District Court, Parish of East Baton Rouge, State of Louisiana	Yes 12/09/2008		08139.00
Simon Eddins & Greenstone, LLP	No. BC373142	Barbara Gaia, et al. v. Allis Chalmers Corporate Product Liability Trust, et al.	The Superior Court of California, County of Los Angeles	Yes	Yes	07079.10
Simon Eddins & Greenstone, LLP	Cause No. 2008-36868	Jerry Johnston, et al. v. Afton Pumps, Inc., et al.	11th Judicial Court, In the District Court, Harris County, Texas	Yes 07/29/2009	Pending	07079.07
Simon Eddins & Greenstone, LLP	No. 2009-18278	Charles Leonard Willis et al. v. Alcan Products Corporation, et al.	District Court of Harris County, Texas, 11th Judicial Court	Yes	No	07079.12
Simon Eddins & Greenstone, LLP	C/A No. 2008-CP-23-9186	Estelle Firth v. AGCO Corporation, et al.	In the Court of Common Pleas, County of Greenville, State of South Carolina	No	Yes 6/25/10	07079.09
Martzell & Bickford	Number: 63,885	Leroy B. Picard v. Georgia-Pacific, et al.	18th Judicial Court, Parish of Iberville, State of Louisiana	Yes	Pending	08139.03

Martzell & Bickford	No. 119-088	William Albritton v. Cleco Corporation, et al.	16th Judicial District Court, Parish of St, Mary, State of Louisianna	Yes 07/28/2009	No	08139.04
Martzell & Bickford	No. 08-8077	Lorie Wells and Alan Wells v. Folgers Coffee Company, et al.	Civil District Court, parish of New Orleans, State of Louisiana	Yes 02/19/2010	No	08139.11
Williams Kherkher Hart Boundas, LLP	Cause No. 2006-28088	Linda South v. Union Carbide Corporation ,et al.	11th Judicial District, In the District Court of Harris County, Texas	Yes 04/06/2009	No	08227.00
Simon Eddins & Greenstone, LLP	Civil Action No: MDL875	Charles Leonard Willis et al. v. Foster Wheeler Energy Corporation, et al..	United States District Court, Eastern District of Pennsylvania	Yes 10/09/2009	Pending	07079.16
Martzell & Bickford	No. 68-159-C	Gwen Robert v. Garlock, Inc.	29th Judicial District Court, Parish of St. Charles, State of Louisiana	Yes 11/20/2009	No	08139.05
Martzell & Bickford	No. 09-65682	Clarence Scott Wren v. Cooper/ T. Smith et al.	United States District Court for the Eastern District of Pennsylvannia	Yes 06/07/2010	No	08139.13
Martzell & Bickford	No. 09-65681	Walter McDonald, et al. v. Crowley Maritime Corporation, et al.	United States District Court for the Eastern District of Pennsylvannia	Yes 06/07/2010	No	08139.14

Martzell & Bickford	No. 09-4431	In Re: Richard Dean Petticrew	Civil District Court Parish of Orleans, State of Louisiana	Yes 08/25/2010	No	08139.15
Hissey Kientz, LLP	No. 2009-37869-ASB	Bonnie Thiele v. Union Carbide Corp., et al.	Harris County, Texas 11th Judicial District	Yes 11/05/2010	Yes 12/13/10	10025.00
Martzell & Bickford	No. 09-2923	Evelyn Bodine, et al. v. Maryland Casualty Company, et al.	Civil District Court for the Parish of New Orleans, State of Louisiana	Yes June 2011	No	08139.06
Simon Eddins & Greenstone, LLP	No. 2010-12080	Frank Mumfrey v. Anco Insulation, Inc., et al.	Civil District Court Parish of Orleans, State of Louisiana	Yes 6/30/2012	No	07079.17
Martzell & Bickford	Number 44, 907 Division "C"	Ellis Bourque, Sr., et al. v. Peter Kiewit Sons Company, et al.	Civil District Court for the Parish of New Orleans, State of Louisiana	Yes 12/20/2012	No	08139.16
Martzell & Bickford	No. 2007-8026, Section 11, Division "G"	Joseph C. Trascher, et al. v. Peter Territo, et al.	Civil District Court for the Parish of New Orleans, State of Louisiana	Yes 4/4/2012	No	08139.22
Roussell & Clement		Vedros Case		Yes 4/24/2012	No	12068.00
Simon Greenstone Panatier Bartlett, PC	Case No. 10-CI-002418	Melville Nathanson, et al. v. 3M Company, et al.	Commonwealth of Kentucky, Jefferson Circuit Court, Division 5	Yes 5/3/2012	No	07079.16

[1] Arbitration hearing – April 14, 2003

Simon Greenstone Panatier Bartlett, PC	Case No. 2012-CP-05069	Jackson v. Alfa Laval Inc., et al.	State of South Carolina, County of Greenville, Court of Common Pleas	Yes, 1/16/13	Pending	07079.32
Simon Greenstone Panatier Bartlett, PC	Case No. 2012-CP-10-622	Wolper v. Alfa Laval, Inc., et al.	State of South Carolina, County of Charleston, Court of Common Pleas	Yes, 1/16/13	Pending	07079.33
Simon Greenstone Panatier Bartlett, PC	Case No. 2012-CP-02-00606	Fincher v. 3M Company, et al.	State of South Carolina, County of Aiken, Court of Common Pleas	Yes, 1/16/13	Pending	07079.34

APPENDIX D

GHP STANDARD HOURLY RATE SCHEDULE

May 3, 2013

Technical Support	$55.00 per hour
Support Services	$60.00 per hour
Project Coordinator	$75.00 per hour
IH Tech	$80.00 per hour
CADD with Operator	$85.00 per hour
Industrial Hygienist	$85.00 per hour
Architectural or Engineering Graduate	$90.00 per hour
Sr Industrial Hygienist	$95.00 per hour
Associate Project Manager	$110.00 per hour
Project Manager	$135.00 per hour
Sr Project Manager	$160.00 per hour
Senior Manager / Certified Industrial Hygienist (CIH)	$185.00 per hour
Principal Architect / Engineer / CIH – non-litigation services	$275.00 per hour
Principal Architect / Engineer / CIH – time for deposition & trial	$295.00 per hour

Reimbursement for project-related expenses at cost times 1.20 multiplier.

Payment due within thirty (30) days of receipt of invoice.
Interest on accounts over thirty (30) days past due is 1.5% per month.
Rates are effective April 1, 2006.

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